SCIENCE TEACHER'S WORLD

September 25, 1958 • Vol. 4 • No. 1

This is the teacher's edition of Science World. The magazine students receive lies between pages 4-T and 5-T.

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SCIENCE WORLD sends four useful premiums to teachers entering classroom orders for ten or more student subscriptions. These premiums are our way of saying "thank you" for your help in handling student subscriptions.

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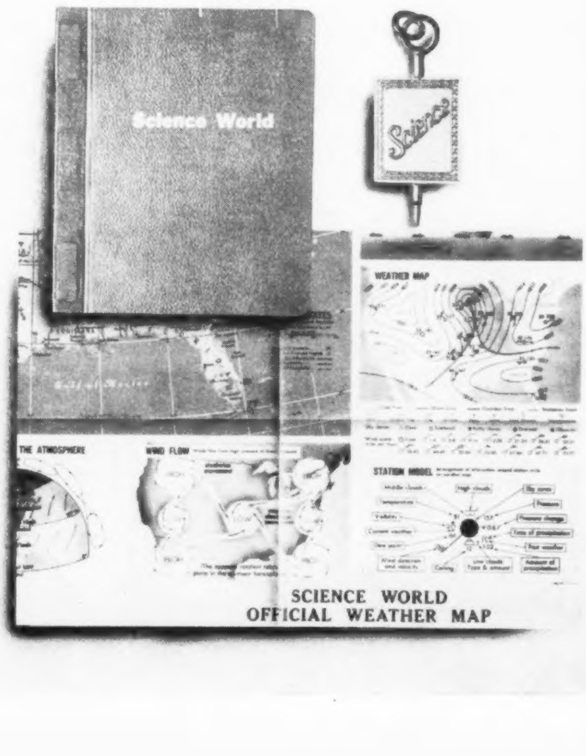
• SCIENCE TEACHER'S WORLD. This is the teacher's edition of SCIENCE WORLD — the magazine students receive plus an eight-page wraparound. In each issue of STW you will find a teaching guide prepared by an experienced classroom teacher, suggesting how to use the material in SW: instructions for making classroom equipment: articles of professional interest.

• EXTRA COPIES. We know that for various reasons it's often desirable to have extra copies of SW. Therefore, for every additional ten classroom subscriptions, you will receive one extra student copy (or teacher's edition, if you prefer). That is, with class-



room orders of 10 to 19 student copies, you receive a free desk copy of STW. With orders of 20-29, you receive your desk copy plus one extra copy of SW or STW. With orders of 30-39 — desk copy plus two extra copies of SW or STW, and so on.

How to subscribe

SCIENCE WORLD is published every other week during the school year. (Included with each order of ten or more student subscriptions is a free copy of the Teacher Edition. Otherwise, the price of the Teacher Edition is the same as a student subscription.)

Subscription rates

One semester (8 issues)	$1.00
School year (16 issues)	$1.50

Address subscription mail to: Science World Subscription Department, 304 East 45 Street, New York 17, N.Y. Simply tell us how many copies (student and teacher editions) you wish to receive. Pay now — or wait for us to bill you later. You may use the postage-free card bound into this issue to notify us.

Trial basis

If you wish, you may subscribe on a trial basis. Examine and use, without obligation, the first issues, dated September 25 and October 14. Then send us our post-free airmail confirmation card. At that time you may revise your order up or down.

How we bill you

After we receive your confirmation, or final order, we send you a bill for only the revised number of copies. You may keep, with our compliments, any extra copies you have received.

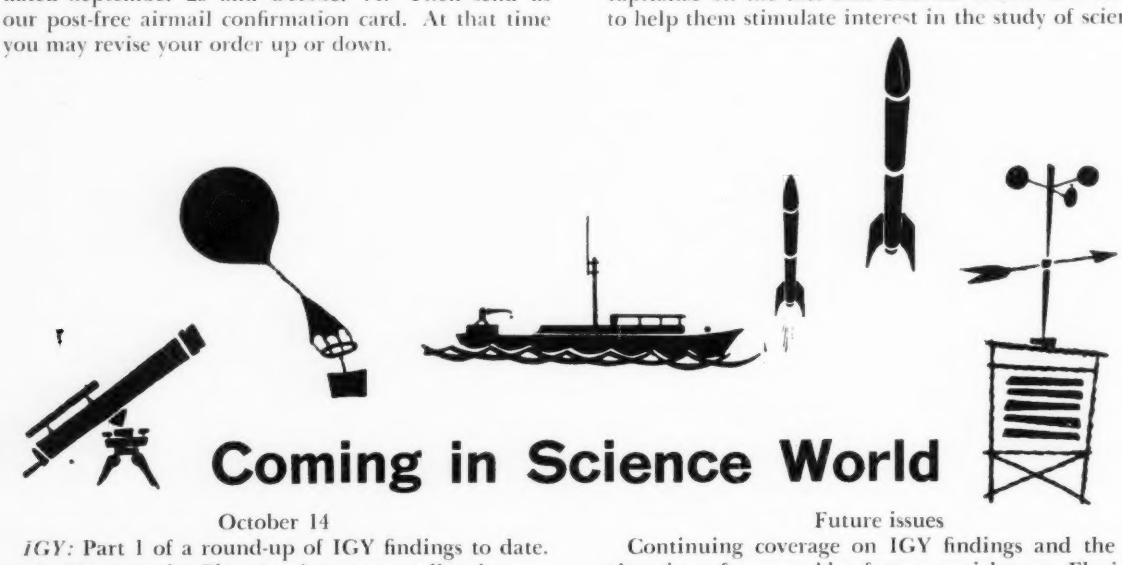
Mailing dates

Because of the early opening date of many schools, the September 25 issue of SCIENCE WORLD is being mailed early. The second issue — dated October 14 — will also be mailed early, reaching schools October 1.

To use Science World

In this era, when science news breaks into the headlines virtually every other day, SCIENCE WORLD is invaluable to both students and teachers who want authoritative coverage and background. For this reason, many teachers set aside time in each two-week period to discuss current science happenings, utilizing the contents of SCIENCE WORLD. Other teachers use the magazine in conjunction with regular classroom studies — either teaching directly from it or using it as a means to tie textbook principles to science in action. Yet other schools use SCIENCE WORLD as a source of material for special reports or extra credits.

But however they use the magazine, all teachers can capitalize on the fact that SCIENCE WORLD is working to help them stimulate interest in the study of science.



Coming in Science World

October 14

IGY: Part 1 of a round-up of IGY findings to date.

Six Steps to the Planets: An expert tells what we must accomplish before man can reach other planets.

Winged Words: An informative and entertaining account of word derivations, which will help the beginning biology students master a new vocabulary.

A-Bomb at Geneva: Means of detecting atomic explosions.

Careers: Heart researcher.

Student project: Falling bodies and the cycloid.

Future issues

Continuing coverage on IGY findings and the exploration of space. Also feature articles on: Florida's red tide, peaceful uses of fusion, conversion of heat into electricity, the senses of man, the science of biogeology, recent studies of barn owls' hearing, weather control, tidal power, antibiotics on the farm, cancer research, vaccine production, color blindness, binary arithmetic, set theory, game theory, low-temperature research, the discovery and development of steroids — to name just a few.

MEMO

To: Science teachers

Subject: Ways to use this issue of SCIENCE WORLD in the classroom

NOTE: *For your convenience, articles that apply particularly to one science subject are described under that subject heading. Articles of a more general nature that cover more than one subject are under the heading of General Science.*

BIOLOGY

ARTICLE: Plants that eat animals (p. 7)
TOPICS: fungi, bladderworts, and larger carnivorous plants

Six plants are described, progressing in size from simple fungi to the Venus's-flytrap and the pitcher plant. The last two are well known and are treated in most biology texts. However, the others should open up a new vista to students. In biology classes that begin the year's work with a survey of the plant and animal kingdoms, the teacher might well assign this article to motivate the study of molds, bladderworts, and higher plants.

The article includes a careful description of the action of each type of plant. Some of the material lends itself very nicely to home project work by students. Another possibility is to have a group of students work together on experiments and then report to the class. The teacher may want to set aside twenty minutes a week for such reports, based on this article and others that will appear in SCIENCE WORLD.

Discussion questions

1. How do plants differ from animals?
2. Why is *Euglena* a biological puzzle?
3. How do some fungi ensnare their tiny animal victims?
4. Why can we call the bladderwort a complicated plant even though it belongs to a group of simple plants in the evolutionary scale?

Projects and experiments

1. Nematodes can be found in the soil around the roots of plants. Look for carnivorous fungi by observing this soil under a microscope. Culture the fungi on Sabouraud's medium, as follows: in one liter of tap water dissolve 10 grams of peptone and 20 grams of pure agar. Then bring just to a boil. Add 40 grams of maltose. Filter the mixture if necessary. Now sterilize for thirty minutes in a pressure cooker or autoclave at eight pounds of pressure. Pour into sterilized dishes or test tubes. It's now ready for use. (NOTE: *there is no adjustment for pH required.*)
2. Send to a biological supply house for living samples of potted Venus's-flytraps and pitcher plants. Have students raise them. Keep them away from direct sunlight and do not allow them to become too dry. When insects are trapped, students can time the sequence, total time of digestion, etc.
3. Have students take photomicrographs of the carnivorous fungi and compare them with photos of other microscopic fungi in their textbooks.

SCIENCE FICTION: A very special kind of goose (p. 24)
TOPIC: embryology

Isaac Asimov's story is not science fiction as the term is normally used. It is, rather, a science puzzler cast in the form of a story. The solution to the puzzle is given below in a letter to Dr. Asimov.

After some class discussion of the story, you may wish either to lead students to the correct solution or to assign them to write their own solutions in the form of a letter.

Students will be interested to know that Dr. Asimov is associate professor of biochemistry at Boston University School of Medicine — and a widely published writer of science fiction.

DEAR DR. ASIMOV:

If The Goose is making gold out of oxygen 18, the obvious first answer is to keep her away from oxygen 18.

The problem has the interesting characteristic that the only way to get golden-egg-laying geese is to make The Goose stop laying golden eggs! But while it's easy to say, "Keep out the oxygen 18," the next problems are "How?" and "How completely?"

The Goose is, however, perfectly equipped to solve the problem. At Argonne National Laboratories they already have completely sealed greenhouses, where they grow plants in radioactive atmospheres. Dump one of those greenhouses, plant necessary ordinary weeds and install The Goose and a gander and leave them alone. In a sealed system, if one component is irreversibly transformed into something else, the system will be freed of the initial component eventually. The Goose herself, then, is the best mechanism for removing the O-18 from air, food and water; she'll turn it into gold. Once in a completely sealed environment, in a few weeks or months all perceptible O-18 will be used up and The Goose will stop laying golden eggs and start hatching goslings.

Since geese are plant-eaters, all they need to keep going is plants, water, and plenty of sunlight to make the plants grow. This the two geese can get readily in a greenhouse.

When the goslings hatch, research can proceed on the next question: If this type of goose turns O-18 into gold and has to get rid of it in the eggs to keep alive — can a gander of the type live at all? He can't throw away gold in the form of eggshells!

Sincerely,
DON A. STUART

Discussion questions

1. How closely does the story follow the actual embryology of a real goose?
2. Can gold, a very inactive metal, replace calcium, an active metal, in shell formation?
3. Why do chickens and similar fowl eat crushed oyster shells and other calcium carbonate sources?
4. What would happen if a female goose did not get any calcium carbonate in its diet?

Projects and experiments

Have a group of students dissect a female chicken to show the reproductive system. Then have them incubate fertile eggs in a homemade incubator. This can be made from a large carton heated by a single 60-watt bulb. Temperature can be controlled by an ether wafer thermostat purchased from a poultry raisers' supply house or from a large mail order company. Set the thermostat at 103° F. Use a thermometer to double-check the temperature in the incubator.

CHEMISTRY

ARTICLE: It's not just water (p. 4)
TOPIC: water

Since water is usually studied during the first few weeks of the chemistry course, this article is particularly timely. It can be used by other science teachers, too. The material deals primarily with the chemical nature of water and the problems of securing and conserving present and future water resources. Many of the experiments mentioned in the article can be duplicated on a small scale in the classroom.

Discussion questions

1. What is one method of reducing water evaporation?
2. What methods for converting sea water to fresh water are being tested?
3. Why is the need for new sources of water and for the conservation of present-day sources so imperative?

Projects and experiments

1. Decompose water by electrolysis. Use sodium sulfate as the electrolyte. If desired, stainless steel electrodes can be substituted for platinum electrodes.
2. Make a still for converting salt water to fresh water, as follows: Stack on top of one another three angel-food cake pans (each with a center tube). Pour salt water in the lower pan, cold fresh water in the upper one. Heat the lower pan. The steam will rise into the middle pan. When it touches the bottom of the cool upper pan, the steam will condense. The fresh (distilled) water will collect in the middle pan.

GENERAL SCIENCE

ARTICLE: Where time begins (p. 10)
TOPIC: time

This article describes the history and the work of the world-renowned Greenwich Observatory. It develops the difference between solar time and sidereal time. Not only do students get a glimpse of the workings of the Observatory, but they also learn something about the equipment used. The accurate quartz-crystal clocks, for example, are explained. This article can serve as an excellent introduction to or summary of the topic of time.

Discussion questions

1. Why was the Greenwich Observatory moved?
2. Why is accurate timekeeping essential to modern civilization?
3. Why is Greenwich time standard for navigation? [*Continued on p. 5-T*]

YOUNG SCIENTISTS

Teachers are urged to have their students submit write-ups of interesting projects or experiments they have done. If printed in SCIENCE WORLD, full credit will be given to the student, the school, and the teacher. In addition, the student will receive $15. Contributions should be addressed to Science Project Editor, Science World, 575 Madison Avenue, New York 22, N.Y. Students should be reminded that by submitting their ideas they can do a service to thousands of other students.

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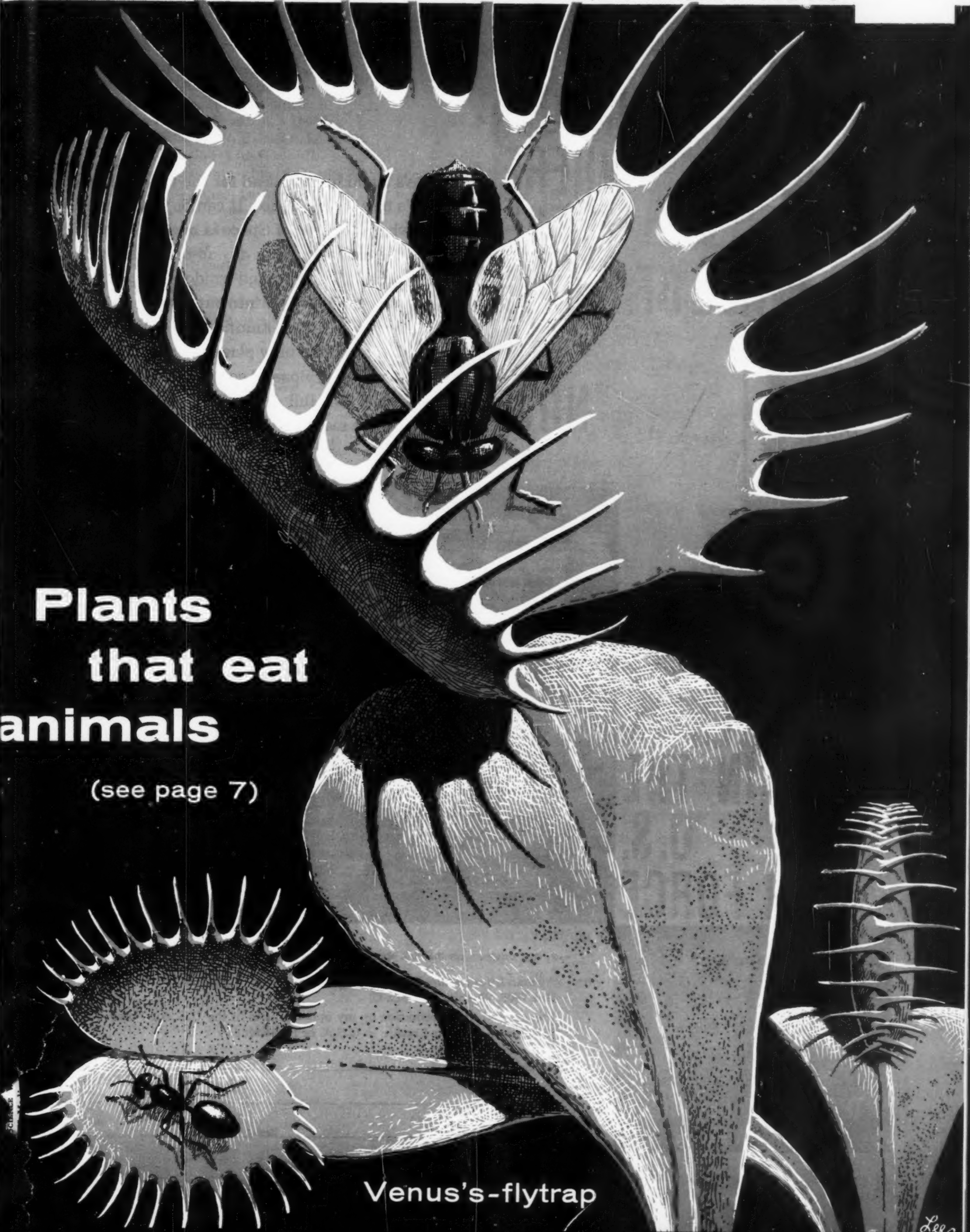
SCIENCE WORLD

SEPTEMBER 25, 1958 • THE SCIENCE MAGAZINE FOR HIGH SCHOOL STUDENTS

Plants that eat animals

(see page 7)



Venus's-flytrap

Lees

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SCIENCE WORLD

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Six Steps to the Planets
IGY Roundup
Winged Words of Biology
Also, career tips, project suggestions, science fiction, science news, and many other features.

Contents • September 25, 1958 • Vol. 4 • No. 1

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This first issue is mailed ahead of schedule because of the early opening dates of many schools. The second issue, dated October 14, will also be mailed early. After that, copies will be received about a week ahead of the date of issue.

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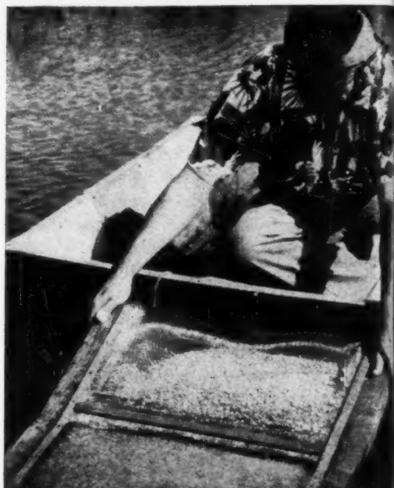


IT'S NOT JUST WATER

Water is involved in an amazing variety of studies and projects that range all the way from solar stills to radio divining rods, from the life and death of a bubble to survival at sea

By Harry M. Schwalb

• On the campus of the California Institute of Technology is a little-known hydrodynamics laboratory. There, researchers shoot 30,000 motion pictures a second. Their purpose: to stretch to *23 minutes* the life history of a tiny water bubble that exists *less than a second*.

• In the stillness of his book-lined study at Royal Holloway College, Surrey, a British physicist unravels the secret of the perfect star-shaped snow crystal. How, he wonders, does each growing arm "know" just how the other arms are growing.

• At Southwest Research Institute in San Antonio, Texas, there's a strange, heavily insulated trough that scientists call their "fur-lined bathtub." In this trough are battery jars containing hundreds of substances — from layers of chemicals one molecule thick to jumbles of ground-up plastics and cork. These are tested for their ability to forestall water evaporation.

These are but three of an amazing range of research projects involving, directly or indirectly, water. Even the delivery of water to our homes is little less than astonishing. As Dr. Harold Vagtborg, chief of the Southwest Research Institute, puts it: "Can you imagine delivering a ton of any other commodity, under pressure, to a Fort Worth third-floor apartment at the insignificant price of a nickel a ton?"

Big splash

Today, the U.S. alone splashes away 262 billion gallons of water a day. By 1975, the figure may double. Hence the tremendous interest in current efforts to turn the ocean into a source of fresh water.

What stands in the way is cost. The average cost of municipal water in the U.S. comes to about 20 cents per 1,000 gallons. Sea water can be converted into fresh water by distillation. But no present distillation equipment can supply fresh water for less than from $1.50 to $3.00 per 1,000 gallons.

So the drive to break through the cost barrier is on in earnest. The U.S. Office of Saline Water (Department of the Interior) alone has had as many as fifty different sea-water-conversion projects going. These have included freezing, solar, and electrochemical processes, as well as distillation.

Typical of the *non*-typical innovations in this field is a multistage centrifugal evaporator (about six years from final development). This will have a tier of whirling trays mounted on a rotor. Salt water will be distributed to the trays. Steam, introduced below the trays, will whirl them around — and at the same time vaporize the water. The vapor will condense as fresh water on trays in a tier above. Then the water will flow off into a trap. A compact unit only twelve feet high by ten feet in diameter, whirling a half-dozen stacks of twenty to fifty trays each, could produce from 100,000 to 200,000 gallons of fresh water a day.

Hot and cold

Other researchers, pointing out that sunlight is free, are busy perfecting solar stills. These are series of evaporation basins under a glass or plastic roof. Salt water evaporates under the sun's heat. The salt is left behind when the water condenses on the underside of the roof. Then the water trickles down into catch-basins. Such a system could be built into the ground to take advantage of the earth's insulation effect; there it might distill 0.8 gallon per square foot of water per day.

Another alternative is freezing, which can also be used to separate impurities from water. This has a

Adapted from the magazine The Laboratory, *courtesy of Fisher Scientific Company.*

Westinghouse Electric Corp.

"ADRIFT" ON WESTERN POND *(left)*, chemist spreads chemical-compound called hexadecanol on water's surface. A thickness of one ten-millionth of an inch will reduce evaporation, thus conserving water. Material is tasteless, odorless, and harmless to aquatic life and higher animals. Water also figures in soap-bubble experiment *(right)*. Researchers use soap bubbles to duplicate atomic crystal structure of metals so defects can be investigated.

Spotlight on water

Major strides are now being made toward meeting the world's pressing need for more fresh water. President Eisenhower emphasized this in his recent speech before the United Nations.

Two new approaches to the water problem have been opened up by advances in atomic science. They are:

1. A little radioactive material is put into an underground river. The movement of the material is traced by instruments that detect radioactivity. In this way the river's course beneath the earth is plotted. The river can then be tapped in various places for water.

2. Nuclear reactors may be used to convert sea water into fresh water. The hoped-for result: a cut in cost. Cost is the chief stumbling block to the wider use of ocean water.

theoretical advantage: it should take less heat energy to freeze water to a slush stage than to boil it. The simplicity and flexibility of this method, especially in large-scale operations, is promising. Already, Battelle Memorial Institute researchers have prepared excellent drinking water (containing total salts of less than 10 parts per million) from natural sea water via controlled freezing.

Scientific dowser

The search for fresh water goes on by land as well as by sea. Cairo University scientist M. A. H. El-Said uses a "radio divining rod" to find the water table beneath the Egyptian desert.

He directs a radio wave at the ground. Part of the wave travels along the surface; another part goes down until it strikes water and is reflected. These two distinct waves, slightly out of phase, are picked up by an antenna placed on the ground several hundred feet from the transmitter. By moving the antenna or varying the transmitting frequency, El-Said regulates the degree of interference, measures the water depth.

In addition to searching for water, scientists are trying to hang onto the water we already have.

In well-publicized tests in the American West, in Australia, and in Africa, a one-molecule-thick coat of the chemical compound hexadecanol was spread on the surface of reservoirs and lakes. Result: it eliminated more than 65 per cent of the evaporation loss. The sperm-oil alcohol molecules of this compound stand on end on the surface of the water like bristles on a brush. They are so closely packed that water molecules cannot escape — though oxygen passes freely.

Researchers are even trying to salvage, for emergency use, water contaminated by atomic bomb explosions or atomic waste accidents. The Oak Ridge National Laboratory uses ion-exchange resins in a process similar to that used in many home water softeners.

The fall-out from a fair-sized bomb could be handled by this method. It takes 15 to 30 minutes and can be used by any householder.

Mutilating fizz

Yet other studies concern the damaging results of water's bubbling effect. Water bubbles pepper pipes with holes, chew up ships' propellers, rip the valves and gates of giant dams. These bubbles have been under painstaking study for decades in the hydrodynamics laboratory at California Tech.

The lab has found that all ordinary water is full of weak spots. (Remove these weaknesses, and the water actually becomes gluey.) The weak spots are torn open into cavities by a fast-moving propeller or are knocked open when fast-moving water turns a corner in a pipe. In these cavities, bubbles filled with water vapor are born.

Any microscopic speck of undissolved matter (gas or solid) is a flaw. By removing or dissolving all the foreign materials in a small body of water, the Pasadena scientists have been able to hang heavy weights from the water without breaking its ropelike structure!

Time will tell

The years devoted to bubbles by the California lab are typical of the length of time required by most studies connected with water. For water yields its secrets slowly. It took four years for Foster D. Snell, Inc., chemists to develop a chemical water repellant for high-speed jet aircraft. The repellant makes rain roll off like beads of mercury. And ten years of data-collecting preceded the pronouncement that the fluoridation of water increased resistance to dental caries.

Even in 1958, such traditional subjects as the snowflake, the structure of water, the cause of "funny" tastes and odors in industrial-area streams, and the nature of thirst are still newsworthy. In England, for example, a physicist has been studying the six arms of the perfect star snowflake. Though the arms grow independently, a complex treelike pattern is repeated closely in each of the six arms. The physicist found evidence that the freely falling crystal may be vibrating mechanically, like a flat plate.

When water-vapor molecules adhere locally to any one region on a snowflake arm, this immediately introduces a localized damping action on the vibrations. This damping action is felt simultaneously at corresponding positions on the other five arms, adjusting *their* rate of water-vapor pick-up.

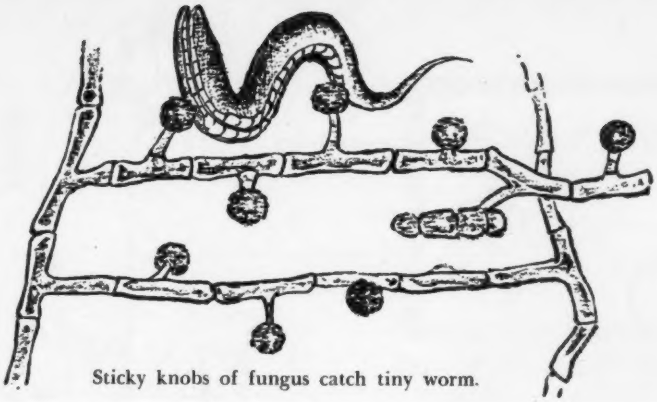
The structure of water is, even today, a major project in a variety of countries. That water is *not* a simple substance is generally accepted. It has, in fact, been considered everything from $(H_2O)_2$ to $(H_2O)_{23}$. There is no agreement as to whether these "associated" molecules exist as free individuals or form the blocks of a still larger structural unit. With today's instruments, scientists are finally beginning to close in on the structure of water.

More down-to-earth is the approach of Mellon Institute chemists. They are working on the problem of water pollution in the Pittsburgh area. In the laboratory they study water tastes and odors. They then go out to nearby streams, filtering 500 gallons of water at a time with their mobile lab's activated-carbon filters. Lab results are checked against actual conditions. The chemists are finding that most of the pesky phenol load in the Pittsburgh area streams probably derives from natural rather than industrial sources. The fermentation of oak leaves, for example, is one cause.

Ship ahoy!

In 1958, clinical science still asks if shipwrecked men can survive on sea water. Experiments on the reaction of salt water with the human system have been conducted for the French Navy by Dr. Alain Bombard (who drifted from the Canaries to Barbados on a raft in 1952), by a team of U.S. scientists under Dr. E. F. Adolph, and by the British physician, MacDonald Critchley.

Modern science has given the castaway two excellent tools: a tiny de-salting kit that precipitates dissolved salts in sea water with silver aluminum silicate briquets; and a small spherical plastic envelope that inflates into a solar still. However, as of mid-1958, clinical results indicate that modern man, adrift on the sea, is no more able to survive than was Coleridge's Ancient Mariner.



Sticky knobs of fungus catch tiny worm.

Plants that eat animals

By Roy A. Gallant

To capture their victims, flesh-eating plants use traps among the most ingenious ever known

Here's an innocent-sounding — but tricky — question: what are three or four differences between plants and animals?

One of the stock replies is that plants attach themselves to the ground, whereas animals do not. But there are microscopic one-celled plants called diatoms that move freely through their salt- or fresh-water homes. Then there are animals that attach themselves to rocks and never move. These are the tiny sea corals (madrepores) that cling to reefs. Throughout its life each individual animal remains fixed to its rock base. After it dies its sharp skeleton is left on the reef.

One obvious difference between plants and animals, you might say, is that plants manufacture their own food by photosynthesis, and animals do not. Yet there are exceptions to this, too. Consider the one-celled organism known as the *Euglena.* It's a remarkable creature to watch under a microscope. Shaped like a fat cigar, it has a long whiptail which it uses to propel itself through the water. Like plants, the *Euglena* has green pigment called chlorophyll. This enables it to manufacture its own food. Yet the *Euglena* also has a mouth and gullet. It can swallow and digest food as do the more complex animals. This baffling creature is a biological puzzle. Is it a plant or an animal? Take your choice. Zoologists include it in their textbooks as an animal, and botanists include it in theirs as a plant!

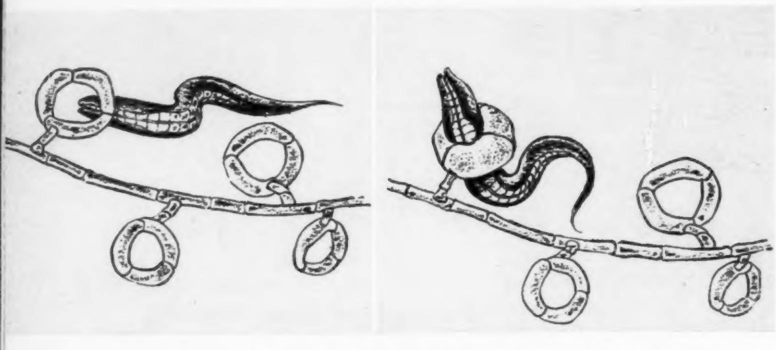
In a final attempt to distinguish between plants and animals, you might offer this thought: animals eat plants, but plants don't eat animals. Again, this is most often the case, but not always. Anyone who is looking for a hobby can spend many fascinating hours watching several remarkable plants that trap and consume live animals. Some of these plants are microscopic in size. Others are a foot or more high. Six carnivorous (flesh-eating) plants are described briefly in this article.

The two smallest belong to a group of fungi called molds. A pinch of garden compost or forest soil placed under a microscope will reveal dozens of these tiny plants. They trap a variety of microscopic animals. Among the plants' victims are the amoeba, small crustaceans, rotifers, and nematodes. Nematodes, which we will be concerned with here, are tiny worms about 1/64 of an inch long, though some are larger. Since nematodes are notorious crop-killers, animal-eating fungi are a farmer's friend indeed.

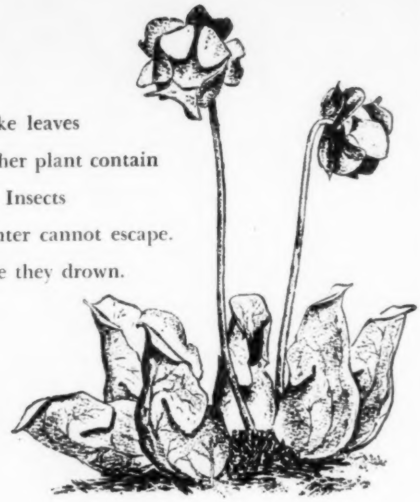
Lethal lollipop

One of the simple fungi (*Dactylla asthenopaga*) resembles a twig with tiny lollipops sticking out along its sides. In fact, biologists call this variety the "lethal lollipop." An unwary nematode that wiggles against one of the small knobs becomes stuck fast, like a fly caught on flypaper. The more the worm wiggles, the tighter it sticks, as more and more of its body touches the sticky knob. The "glue" is an adhesive fluid secreted by the fungus. Soon after the fungus has trapped its victim, the knob inserts spearlike filaments into

Drawings by William Bryant



One killer mold traps its victims in loops resembling rabbit snares.



Vase-like leaves of pitcher plant contain water. Insects that enter cannot escape. In time they drown.

the worm's body. These filaments absorb and digest the nematode, leaving only an empty, wrinkled skin.

A second killer fungus (*Dactylaria gracilis*) traps its victims in a sort of rabbit snare. One mold plant may have hundreds of loops, which resemble doughnuts, attached to a long branch by short stalks. Every loop is made up of three cells, and its opening is just large enough for a nematode to wiggle through. When an unwary nematode touches the outside of one of the loops, nothing happens. But when the worm sticks its head inside a loop, it is doomed. Within 1/10 of a second the three cells expand two or three times in volume. This tightens the loop, exerting a strangle hold that the struggling nematode cannot break. Soon the cells project spearlike prongs into the worm's body, killing and consuming it. All that is left is the worm's hollow skin.

Sometimes a nematode, in its thrashing to free itself, sticks its tail into a second loop. This simply speeds its doom. Other times a large worm, wiggling violently, manages to break a loop off its stalk. But even though the loop is detached from the plant proper, it inserts deadly prongs into the nematode.

This remarkable mold is extremely sensitive to nematodes. If there are no nematodes in the soil, the plant lives perfectly well on decaying organic matter. And it doesn't grow its deadly loops. But wet the soil with water in which nematodes have lived, and the plant will quickly develop nematode traps. Any amateur biologist with a microscope can easily watch these killer plants at work and make sketches of their feeding habits.

The bladderwort

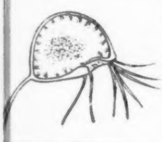
A third plant that traps and eats animals is the bladderwort (*Utricularia vulgaris*). It is a plant commonly found in swampy water or in shallow inlets of lakes. Chances are that you have seen this plant without recognizing it for what it is. A rootless plant, the bladderwort floats just beneath the surface of the water, sporting attractive yellow flowers, about ½ inch in diameter, above the surface. If you pull the plant out of water, you will find hundreds of small sacs — about ⅛ of an inch long — arranged along a stem several feet long. A good magnifying glass will reveal these sacs as deadly traps for small animals.

Water fleas (*Cyclops* or *Daphnia*) are common victims of the bladderwort, as are nematodes and insect larvae. An animal as small as the one-celled paramecium can touch off the sensitive trap. Here is how it works:

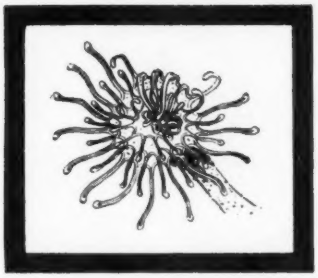
Each tiny bladderwort sac is lined with hundreds of small hairs called quadrifids. These hairs have two functions. First, they absorb water from inside the sac. Second, they secrete digestive juices. At the top front of each sac is a tiny trap door that can spring open and shut. In its closed position the door is completely watertight. As the hairs inside absorb the water in the closed sac, the water pressure inside the sac drops below the pressure outside. The sac's walls then cave in like the squeezed bulb of a rubber syringe.

Outside and just below the trap doors are from four to six stiff trigger hairs. If a small animal swims close to a sac and brushes against one of the trigger hairs, the animal springs the trap and is doomed to a slow, cruel death. The stimulated trigger hair causes the trap door to snap open. Water rushes in to equalize the inside and outside pressures — and carries with it the animal. In the process the collapsed walls of the sac puff out to the full position. The opening and closing of the trap door takes only 1/35 of a second! This super-fast action in a plant is a phenomenon that has amazed biologists.

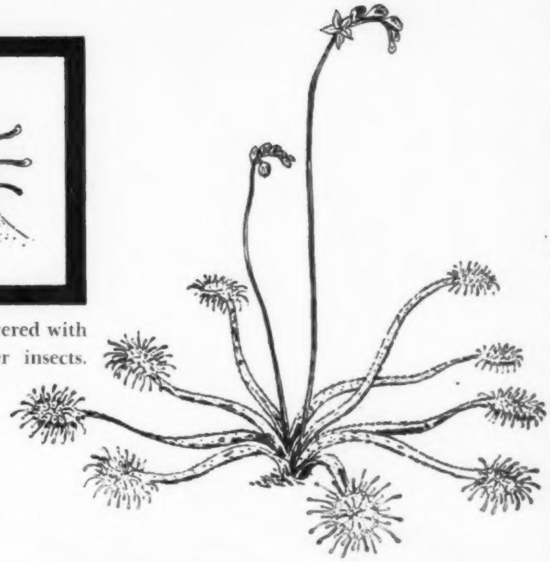
Once inside, the animal has no chance of escape. Slowly the water within the sac is drained off by the hairlike filaments. These also secrete juices that slowly digest the animal. As the sac consumes its prey, the walls collapse, readying the trap for the next victim. One sac may contain several animals, trapped one after the other.



Animal that touches trigger hairs of bladderwort sac is sucked inside.



Leaves of sundew are covered with tentacles that close over insects.



If you own a microscope and are looking for interesting subjects to view, the bladderwort is recommended. One biologist found a single plant with 610 sacs attached to it. More than 500 of the sacs held a total of 2,084 trapped organisms, ideal for microscopic viewing.

Venus's-flytrap

Among carnivorous plants large enough to watch without a microscope are Venus's-flytrap, with its snapping jaws (see SW's cover); the pitcher plant, with a well in which it drowns victims; and the sundew, with its deadly tentacles.

Venus's-flytrap plants are found in sandy bogs near the coast of North Carolina and reportedly in Florida. The trap part of the plant is a tongue-shaped leaf with fifteen or so spines along each edge. The leaf is "hinged" down the middle so that it can open and close like a checkerboard. On each leaf half are three small spines that trigger the plant into action.

When a fly alights on the leaf and touches one of the trigger spines, the leaf snaps closed within seconds. The interlocking spines along the leaf's edges trap the fly in a cage of death. Slowly the leaf's surface begins to secrete digestive juices that dissolve the soft part of the fly's body. The leaf tissues then absorb the dissolved fly, so providing the plant with food. The entire process takes about fourteen days. Then the trap opens and is set for the next unwary victim. The dried, undigested portion of the previous captive is blown away by the wind.

Although the pitcher plant is less "imaginative" than Venus's-flytrap, it is just as deadly. Different varieties of the pitcher plant are found in swamps east of the Rocky Mountains and east of the Mississippi River. Others are found at high elevations along the Pacific coast. There's no mistaking the pitcher plant. Its leaves are shaped like deep narrow vases. Rain collects in the vases, forming deep wells in which the plant's victims are drowned.

Insects are attracted to the plant by a honey-like substance secreted by glands at the mouth of the pitcher. Once inside the vase, an insect finds that it cannot get out without being pierced by long downward-pointing sharp spines growing around the rim. Eventually, the insect drops exhausted into the well and is drowned. Digestive juices of the plant then break down the insect's fleshy parts, and the plant tissues absorb them. Carrion-feeding insects are often attracted to the plant by odors given off by insects trapped and decomposing inside. So the plant has two "baits."

The sundew is a plant that snares its victims with tentacles as deadly for their size as those of an octopus. It is common in the U.S., growing in bogs and wet ground. The poorly developed roots of the plant serve mainly to anchor it and supply it with water. Since the plant is a flesh-eater, its food comes from the insects it catches.

Below white or purplish flowers of the sundew are leaves whose top surfaces are covered with small tentacles. At the top of each tentacle is a gland that secretes a sticky substance. When a fly alights on a leaf, it immediately becomes stuck fast. The more it struggles, the more surrounding tentacles it stimulates. Gradually, twenty or more tentacles weave around until they touch the fly and force it toward the leaf's surface. There they smother it in a sticky discharge. Each gland touching the fly secretes digestive juices that enable the leaf tissues to absorb the soft flesh of its captive. After the plant has consumed its prey, the tentacles straighten up and the wind blows away the skeletal remains. In hot climates some people grow sundew plants in their living rooms to catch flies.

No man-eaters

All the carnivorous plants have poor root systems that fail to supply the plants with as much nitrogen as they need. But this deficiency is made up by the nitrogen and protein the plants absorb from their insect prey. Some large varieties of carnivorous plants reportedly have captured birds and small mammals. But outside of science fiction none has been known to capture a man.

WHERE

Illustrated by Peter Burchard

To find where the world's time begins, you must go to the borough of Greenwich, some three miles east of the center of London, England. Here, at the one-time site of the Royal Greenwich Observatory, is an asphalt pathway with a brass strip. The strip marks the exact position of the Greenwich meridian — that imaginary north-south line from which our time measurements are calculated.

Beginning of world-time

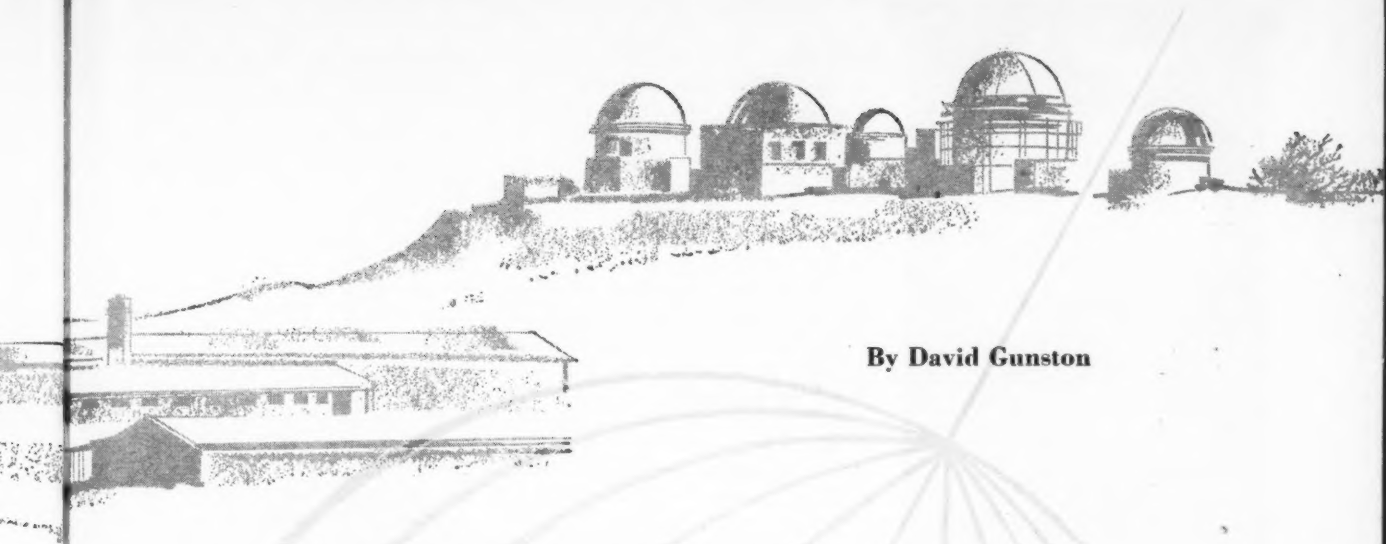
The idea of having a fixed time system for the whole world dates only from 1884. Before then, different countries and regions all had time systems of their own. The resulting confusion came to a head with the development of railroads. Railroading required standard schedules. And this hastened world acceptance of a time system based on what is known as Greenwich mean time.

Like most good ideas, this one is basically simple. The whole earth is considered to be marked off by twenty-four standard meridians, each 15° apart in longitude. A meridian is an imaginary line running from pole to pole. And the prime meridian — 0° — runs by international agreement through Greenwich. This is where time begins.

Each meridian is the center of a time zone. So there are twenty-four time zones in all. When we pass from one zone to the next, time changes by one hour. Going west from Greenwich, the time is one hour earlier in each zone; going east, it's one hour later. This means that at longitude 180° east — at the opposite side of the earth from Greenwich — we also meet longitude 180° west. The meeting place is known as the international date line. When it is crossed, usually by ship or plane, a whole day of twenty-four hours is gained (going east) or lost (going west).

The Observatory moves

The Greenwich Observatory was established in 1675 primarily to improve the navigation of ships at sea. It mapped the heavens accurrately. This helped sailors to determine their position at sea by observing stars. Such work — astral observation — has always been an important job at the Observatory, though its staff has also made many discoveries in general astronomy. For the last seventy years or so, however, the Time Department has been its most important division.



By David Gunston

E TIME BEGINS

Oddly enough, a visitor to Greenwich today will not find the Observatory. The establishment has left its traditional London home and moved to the quiet village of Herstmonceux (pronounced hurst-mun-*soo*) on England's south coast some sixty miles away.

The move was dictated by necessity. London's industrial smoke and the glare of its street lights and illuminated signs increasingly obscured the sky, making astronomical observations most difficult.

No change in meridian

However, the shift in no way affects the value of G.M.T. (Greenwich mean time). Careful adjustment is made for the new observatory's position, slightly east of the original meridian.

Today the accuracy of the world's clocks depends on the time calculations of a number of major observatories. But to study the world's time-keeping at its source, we must present ourselves at Herstmonceux Castle, now officially known as the Royal Greenwich Observatory. The grounds present a strange appearance. The battlemented towers of the ancient castle, built in 1446, jostle great steel domes and concrete office blocks and quarters for the staff of some eighty scientists.

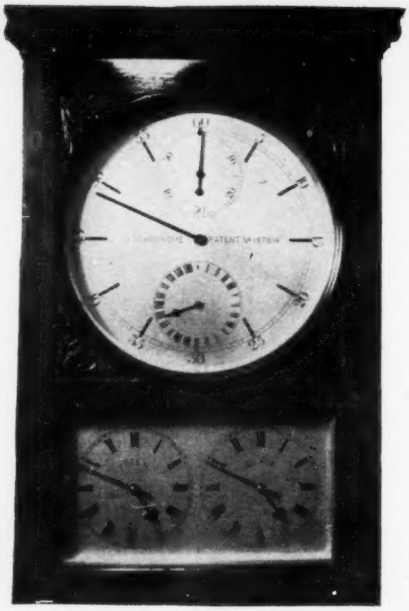
The new, giant, 98-inch telescope, the "Isaac Newton," will, when assembled, occupy the biggest of the six domes and be the largest in the British Commonwealth. But it is just one of many instruments. In the various Transit Circle Departments are telescopes that watch only fixed sections of the night sky. Then there are the equatorial telescopes. These can follow heavenly bodies from their rising to their setting. There is the spectrohelioscope, an instrument designed to tell us more about the physical composition of the sun.

In addition, there are extensive offices for the complicated calculations needed to interpret astronomical observations. The Astrographic Department plots and forecasts star movements. The Magnetic and Meteorological Section is chiefly concerned with observing weather changes. A well-equipped workshop for the repair of various time-keeping devices, a fine library, and staff residences complete the plant.

The time department

Our chief interest is with the compact Time Department. It gives G.M.T. to the world by transmitting its famous six time-signal "pips" every fifteen minutes. Here, there are hardly any clock faces as we know them — only an imposing array of boxed-in electrical gadgets, wiring, and the vital regulator clocks. These look like giant grandfather timepieces, each with three dials.

Staff members of the Time Department are well aware of the world-wide importance of their task. Their clocks must be kept going with the greatest degree of accuracy and without a moment's



—Hulton Picture Library

ONE OF THE FEW clocks at Greenwich that look like clocks is this three-dialer.

break. Observatory clocks must not vary more than one one-thousandth of a second per day!

How is time obtained? Well, the only really accurate time for scientific purposes is star time, or what astronomers call sidereal time. It is obtained by measuring the consistent daily motion of the stars across the sky. (This motion, of course, is the result of the earth's rotation rather than actual star movement.)

The Time Department works hand-in-hand with Transit Circle Department experts. The latter make the stellar observations that keep the regulator clocks accurate. Catalogues (or almanacs) are made of the positions of the stars. The catalogues predict for years ahead a star's exact position in the sky in each hemisphere. From these it is simple to find out when a particular star will cross the Greenwich meridian. Just before this time, a Transit Circle observer opens the telescope slit in his dome and takes up his position behind his special, often quite small, telescope. The telescope is set so the star will pass through its field of vision. The observer now switches on the connected electrical apparatus and waits for the star to appear.

Stretched across the telescope's field of view is a series of fine vertical lines. The middle line is set on the Greenwich meridian. As the center of the star passes over each line, an electrical contact is recorded on a tape chronograph in the main Time Department. Simultaneously one of the many sidereal clocks there has also been making its own time record on the tape. So it is immediately possible to work out the clock's error, if any, and make the necessary adjustment.

The kind of clocks

Reliance is not placed on one clock. There are, in fact, eight clocks in regular use. All of them are the quartz-crystal, controlled-frequency type. In reality, these are electrical instruments rather than clocks. They work on the basic principle that a small, properly cut piece of quartz crystal kept at a constant temperature inside a vacuum tube will oscillate if an electric current is passed through it. These oscillations are practically constant and can be adjusted to a required frequency of, say, 100,000 cycles per second. The clocks are unaffected by earth vibrations, gravitation, or electrical interference. All are securely clamped to the walls and are constantly being checked, by either astral or solar observations.

You may wonder why this complicated method of determining time is used. Would not time measured by the sun's apparent movement be equally useful? The answer to that question is no. The earth and sun are not rigidly constant in their motions in space. The earth is tilted on its axis at an angle of 23½ degrees from the vertical. Its path round the slightly eccentric sun is elliptical and not circular. What's more, its speed varies according to its position in that path (the closer to the sun, the faster the speed).

To use sun time, we would have to assume that the natural day began at noon and not at midnight — that is, when the sun crossed the appropriate meridian. But if the intervals between successive noons throughout the year are carefully timed, they are found to be far from equal. The various eccentricities just mentioned are the reason. The daily variations soon mount up. Clocks set by the sun would be hours wrong within a few months.

Fortunately for science, no such errors are noticeable when sidereal time is used. Compared with our sun, the stars are infinitely distant. In its course around the sun, the earth may shift its position in space by nearly 200 million miles in six months. Yet the relative position of the stars changes so minutely that human calculations aren't affected.

Sidereal time, however, has its limitations, too. Essential for all astronomical work, it is not much good for daily life. The sidereal day — the interval between a star's successive crossings of a meridian — is almost four minutes shorter than the ordinary 24-hour day. This means that a sidereal clock will gain 12 hours on an ordinary clock in six months. Thus sidereal time would not bear any consistent relationship to daylight and darkness.

The meaning of 'mean time'

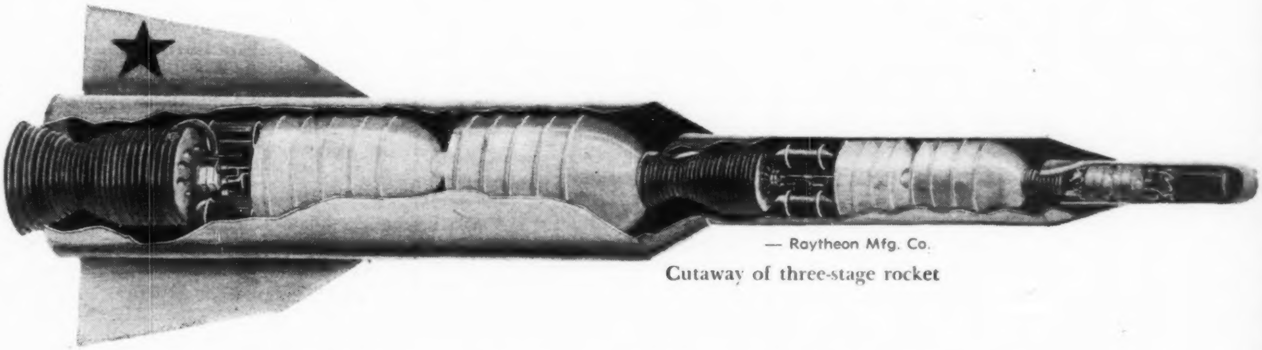
Obviously we must still live our lives roughly by the sun. So for everyday use a practical compromise between solar time and sidereal time has been worked out. This compromise is a system of mean time (equivalent to average time). Mean time is based on the movements of an imaginary sun — the "mean sun" — which is assumed to cross a meridian at uniform intervals. By this device, a mean solar day is always of exactly the same length.

Greenwich mean time, therefore, is a system of mean time calculated from the assumed moment when the mean sun is crossing the prime meridian of 0°.

Though a compromise, the mean-time system works perfectly for all non-scientific purposes. The Greenwich Observatory constantly checks (against its sidereal clocks) the actual rate of timekeeping of the clocks set to G.M.T., especially those two that operate the electronic time-signal pips. By picking up these pips (or the signals from other time-keeping observatories), ships, aircraft, radio stations, and timekeepers the world over can adjust for their own local time. In that way they remain synchronized with the foolproof standard time system essential today.

By T. L. Phillips

Rockets, missiles, and satellites



— Raytheon Mfg. Co.

Cutaway of three-stage rocket

A missile expert explains the principles behind these instruments of space travel and of push-button warfare

Rocketry, strange as it may seem, is not a new scientific development. The Chinese have used rockets as fireworks since before the Christian era. They began using rockets as weapons of war in the 1200's. One Chinese even tried to propel himself into flight by attaching rockets to a homemade rickshaw — an experiment that ended in explosive failure.

Centuries later, in the war of 1812, the British bombarded Baltimore with rockets. That's how the phrase "and the rockets' red glare" came to be in our national anthem, "The Star Spangled Banner."

The idea of using rockets for space flight and for launching earth satellites is not new, either. The theory has been understood for more than fifty years. Three pioneers in this field were a Russian, K. E. Ziolkovsky; an American, Robert Goddard; and a German, Hermann Oberth.

But it was World War II that gave rocketry's development a really big boost. Since then the rocket has reached spectacular prominence. It is now both a deadly military weapon and a tool of scientists for the exploration and conquest of space.

The rocket race

During World War II, scientists in Germany, the United States, England, Russia, and Japan developed various rocket devices. Their purpose: to assist the take-off of aircraft and to propel anti-aircraft and other short-range projectiles. By far the greatest advance was made by German scientists. They built the first long-range rocket-powered missile to be put into operation — the V-2.

The V-2 was developed at Peenemünde under the technical direction of Dr. Wernher von Braun. It was powered by a liquid-fuel rocket engine and it carried an explosive warhead. It could travel at five times the speed of sound. During the last year of the war the Germans used it to bombard London. If the V-2 had been ready earlier, the war might have had a different ending.

Other rocket weapons were developed at Peenemünde. Most of these did not get beyond an experimental stage, but they represented concepts well in advance of the time.

Many of the German scientists engaged in this work were brought to this country where they are now respected American citizens. A group of them, headed by Dr. von Braun, has remained together under Army sponsorship. These scientists have been largely responsible for the development of the Redstone and Jupiter missiles and more recently for the launching of the American Explorer satellites.

Other German rocket scientists have worked behind the Iron Curtain on the Russian missile and space programs.

During the last year of the war our own guided missile program got under way. One of the first projects, assigned the code name "Lark," was to develop an anti-aircraft missile to cope with kamikaze — the explosives-laden Japanese planes assigned to make suicidal dives into our ships. The goal was to produce an operational missile in six months.

But technical difficulties were grossly underestimated. It was years before the Lark successfully intercepted an aircraft drone. Shortly thereafter, another surface-to-air missile, the Army's Nike, performed successfully. So did the Navy's Sparrow and the Air Force's Falcon, both air-to-air missiles. As for surface-to-surface missiles, the Army's Corporal and the Navy's Regulus were among the earliest to prove themselves.

Technical difficulties were by no means the only reasons for slow development of missiles during the early postwar period. Meager funds were a major factor.

The Korean conflict provided a second large boost to missile development. Again, there was a sense of urgency.

Through the early 1950's we did very little work on ballistic missiles of intermediate or intercontinental range. The Russians got the jump on us here. When our radar in Turkey began detecting more and more ballistic missile firings in the Soviet Union, our own ballistic missile program was accelerated to a crash basis. The Air Force was given prime responsibility. It speeded up work on the Atlas intercontinental ballistic missile (ICBM) and began to develop the Titan ICBM and the Thor intermediate range ballistic missile (IRBM). Meanwhile, the Army went ahead with the Jupiter IRBM, the Navy with the submarine-launched Polaris IRBM.

The development of ballistic missiles gave scientists many of the tools needed for research during the International Geophysical Year and for space flight. For example, the launching of the first American satellite was made possible by the Army's work on ballistic missiles.

So much for the history of rocketry. Let's now consider two of the most important aspects of missile and space flight: propulsion and guidance.

Space-age definitions

(compiled with the help of the American Rocket Society)

A jet is a self-propelled vehicle operating on the reaction principle.

A rocket is a self-propelled, **non-air-breathing** vehicle operating on the reaction principle.

In both, hot gases from a burning fuel provide thrust. A jet depends on outside air to furnish the oxygen needed for its fuel to burn. But a rocket carries its own oxygen supply. A rocket can operate in airless space.

A missile is any object thrown or otherwise projected. Today's military missiles carry explosive warheads and are powered by rocket or jet engines.

A guided missile is a missile that is guided throughout its flight to the target by a ground or airborne system. It receives guidance by radio, radar, or other means.

A ballistic missile receives a high initial thrust and then coasts through its flight path without guidance.

A satellite is an attendant body, revolving around a larger one. The moon is a natural satellite of the earth. The Sputniks and Explorers are artificial (or man-made) satellites.

How rockets are propelled

Almost all missiles are powered by rocket engines. The rocket-motor principle is described by Sir Isaac Newton's reaction principle: for every action there is an equal and opposite reaction. The action is the rate of discharge of gases through an exhaust nozzle. The reaction is a force (or thrust) that tends to accelerate the motor in the opposite direction. (Not all thrust-developing engines based on the reaction principle are rockets. There are, for example, the air-breathing engines used in jet aircraft and jet missiles.)

A rocket engine differs from the air breathers in two major respects: (1) it carries its own oxidizers and is therefore not restricted to operating in the lower atmosphere where oxygen is plentiful; (2) it develops the highest thrust per unit frontal area of any known engine. These two features combine to make it the only feasible means for space flight.

Rocket engines are divided into two major classes, depending on the state of the fuels before combustion: there are liquid- and solid-fuel engines. Liquid-fuel engines usually consist of two tanks. One contains the liquid fuel, such as alcohol, aniline, or hydrazine. The second contains liquid oxygen or fuming nitric acid. These are injected into the combustion chamber under pressure. There, the fuel is burned. The resulting gases flow out through the rocket's exhaust nozzle. Liquid engines power most of today's large missiles with thrusts of from 100,000 to 500,000 pounds. But they have serious disadvantages. For one thing, it takes a long time to fuel them before launching. And their complex valving systems may not work properly.

In contrast, solid-propellant engines are simple and are ready to be launched at a moment's notice. Solid propellant consists of a rubbery compound made up of both the fuel and the oxidizer. Solid-propellant rocket engines have been built with thrusts of more than 100,000 pounds. But to date they are not large enough to act as the first stage of a ballistic missile or of a rocket launching an earth satellite.

Even the most efficient rocket engines have a top speed of about 10,000 mph at the end of burning. This is far short of the speed required to propel an ICBM 5,000 miles or to put an object into orbit. For these jobs, staged rockets must be used.

When the large first-stage rocket uses up all of its fuel, a second stage ignites and separates from the first stage. The second stage begins accelerating from the maximum speed achieved by the first-stage rocket. Similarly, a third stage may be ignited at the time the second stage uses up all of its fuel, and so on. In this way staged rockets can achieve the 18,000 mph needed to put a satellite into orbit or the 25,000 mph needed to escape from the earth's gravity and reach the moon and beyond. The Russian

Sputniks and the American Vanguard satellite were launched by three-stage rockets. The American Explorers were launched by four-stage rockets.

How rockets are guided

Many different systems are used to guide rockets and missiles. In anti-aircraft missiles radar is chiefly used. It can determine the direction, distance, and speed of the target.

The system generally used for ballistic missiles and space rockets is inertial guidance. Its basic instruments — accelerometers — are located on a gyro-stabilized platform so that they remain properly oriented to the earth regardless of the motions of the vehicle.

The accelerometers record acceleration changes in any direction. These changes are fed to a computer. The computer calculates the position of the missile or rocket and guides it to a predicted point in space. Here the computer shuts off the engine. From that point on, the vehicle is under the influence of gravity alone.

How satellites are launched

An earth satellite can orbit successfully when its speed is such that its centrifugal force exactly balances the pull of the earth's gravitational field. At altitudes of a few hundred miles this speed is about 18,000 mph. Traveling at this speed, the satellite will circle the earth in one and one-half to two hours.

At distances farther from the earth, the pull of gravity is weaker. So a satellite would not require so much velocity to remain in orbit there. But the distance it would have to travel to complete its orbit would be greater. So its period of rotation would be longer.

Satellites are now being used to gather data on outer space. If men can survive the rigors of outer space and if a large enough payload can be put into orbit, satellites may become refueling stations for rocket ships bound for other planets.

There are those who ask why man should want to venture into outer space, anyway. I suppose the most honest answer is the same as that given by Sir Edmund Hillary when he was asked why he had always wanted to climb Mount Everest: "Because it's there."

POISED FOR FLIGHT are three of Army's Hawk guided missiles, designed to destroy low-flying enemy aircraft.
— Raytheon Mfg. Co.

Science in the news

Destination: the moon

The big rocketry news of Summer, 1958, was the United States' attempt to shoot a rocket around the moon. As expected, the first attempt failed. The Air Force's four-stage Thor-Able rocket exploded 77 seconds after launching. The Air Force immediately scheduled a second shot for mid-September. Other moon-shots by both the Air Force and the Army will follow.

The moon-shots will be made at times when the moon swings closest to the earth. Conditions must also be right for photographing the moon's far side. That is one of the main goals of a lunar probe.

We never see the other side of the moon. As it revolves around the earth, the moon always presents the same side to us. When the moon is in its crescent (or new) stage, the far side is illuminated by direct sunlight. This is a good time to photograph it from a rocket.

It may take many tries before a U.S. moon-shot succeeds. But the over-all plan will probably remain the same:

A four-stage rocket blasts off from Cape Canaveral, Florida. The first-stage rocket lifts the vehicle above the earth's atmosphere. Then, its fuel exhausted, the first stage falls away. In succession, the second and third stages ignite, burn, and fall away. The rocket's final stage achieves a speed of about 24,000 miles an hour. It coasts moonward.

Gradually the still-powerful pull of the earth's gravity slows the vehicle. Then, as it nears the moon, the tug of lunar gravity takes over. The vehicle picks up speed. Soon a braking rocket is fired. This slows the vehicle to some 2,400 mph. Lunar gravity now swings the vehicle around the moon. Special photocells and other instruments inside the vehicle record and transmit to the earth electronic images of the moon's other side.

The rocket will send other data, too. As it soars through the top of the earth's atmosphere, it will transmit signals about the deadly band of radiation reported by our Explorer satellites. And it may help us determine whether the moon has a magnetic field similar to the earth's. This will give scientists clues to the moon's origin.

Four satellites in orbit

It may be months before a man-made satellite circles the moon. But meanwhile four such satellites are hurtling around the earth. They are: Russia's Sputnik III, the U.S. Army's Explorers I and IV, and the Navy's Vanguard I.

The newest satellite, Explorer IV, was launched on July 26 (Explorer V, launched last month, failed to orbit). First of the U.S. satellites to pass over Russia, Explorer IV is slightly heavier (38 pounds) than the others we've launched. But it's only about 1/80 as heavy as Sputnik III.

The small U.S. satellites have one big advantage over the Russian heavyweights. They'll have a much longer life. Russia's Sputniks I and II lasted three months and five and a half months, respectively. Pulled by gravity, they gradually dipped deeper and deeper into the earth's thicker atmosphere. They were finally destroyed by the heat from friction with the air. The Explorers should stay in orbit for several years, and Vanguard I for perhaps 200 years.

Million-pound rocket

The size of Russia's Sputniks indicates that they were launched by rocket engines more powerful than any in the U.S. But the U.S. is now beginning work on a giant rocket engine capable of developing one million pounds of thrust. This could carry a 20,000-pound satellite to an orbiting altitude of 1,000 miles. It could also take a 6,200-pound payload around the moon. The engine is being delevoped by Rocketdyne Division of North American Aviation, Inc.

As the race to space quickened, some U.S. military officials set up this timetable for our exploration of the moon:

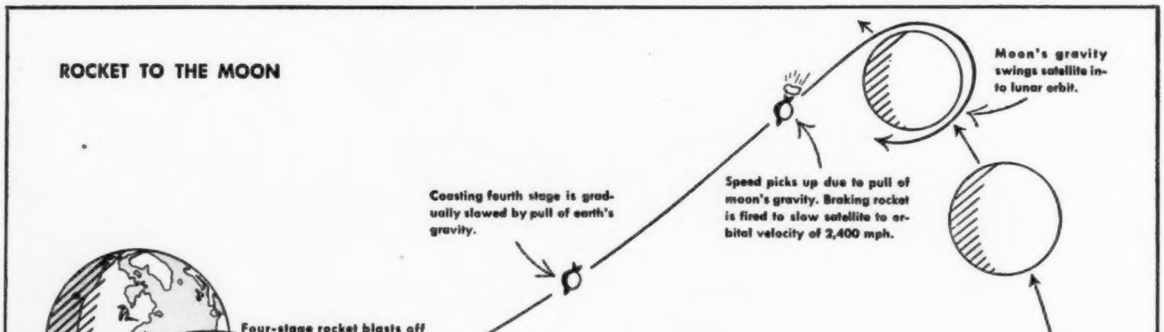
Within one year: a space vehicle will orbit the moon and send back measurements and televised pictures.

Within three years: a manned satellite will orbit the earth.

Within five years: an unmanned space vehicle will circle the moon and return to earth with photographs and data.

Within seven years: a space vehicle with a man in it will go around the moon and return safely to the earth.

FIRST SUCCESSFUL MOON SHOT made by this country will probably work out as shown. Entire trip will take some sixty-two hours.



Drawing by Wes McKeown

Atoms to Middle East?

The power of the atom may be used in the Middle East to bring about the "Arab renaissance" mentioned by President Eisenhower in his recent speech before the United Nations.

One of the Middle East's most pressing problems is lack of water for irrigation. U.S. scientists and engineers are developing techniques to ease our country's own water shortage in the West. If the Arabs accept a U.S. proposal of aid, three of these techniques might be exported to the Middle East. Here's how they would work:

1. Radioactive isotopes could be used to seek out the abundant underground water in the Middle East. Under the Nile River bed, for example, flows a hidden river that carries six times more water than the Nile itself. Radioactive isotopes could be put into the underground river. As they were carried along by the current, their radioactivity would reveal their movements to Geiger counters aboveground. In that way, the water's course beneath the earth could be traced. The river could then be tapped for water.

2. Nuclear reactors could be used to convert sea water to fresh water. The de-salting of sea water is already a necessary operation in the Middle East. But it's expensive. Experiments show that nuclear reactors could do the job at lower cost.

3. Nuclear explosives might be used to blast a connecting tunnel or canal between the Mediterranean and Dead Seas. Water from the Mediterranean would flow downward to the Dead Sea, which is some 1,800 feet below sea level. This flow could provide a source of hydroelectric power for the Arab states.

H-power devices abroad

The devices on view this month in Geneva, Switzerland, may remind visitors of a torture chamber in a grade B horror movie. But they could be of great benefit to man. They may lead to harnessing the power of the hydrogen bomb — to producing a controlled thermonuclear reaction. If this can be done successfully, man will have an everlasting source of power.

The public is seeing these experimental devices for the first time. They are being exhibited by the United States at the Second United Nations Conference for Peaceful Uses of Atomic Energy.

In a thermonuclear reaction, the nuclei of hydrogen atoms fuse. In doing so, they give off tremendous energy. This is the reaction that takes place in the sun as well as in the hydrogen bomb. But temperatures of many millions of degrees are required for the nuclei to fuse.

Some of the devices on exhibit may already have produced a *momentary* controlled thermonuclear reaction. But there is no conclusive proof of this.

Earlier, in Geneva, scientists from all over the world reached an important conclusion: that an international ban on nuclear tests could be policed effectively. For this purpose, they recommended that 180 detection stations be set up throughout the world. Such a network would be likely to detect any secret nuclear test. *[See next issue of* SW *for a full report on this.]*

Under the North Pole

Two U.S. atomic submarines have sailed underneath the arctic ice cap to the North Pole.

First to make the epic voyage was the *Nautilus*. It sailed from Pearl Harbor, Hawaii, to Portland, England, by way of the North Pole. Distance covered under the polar ice: 1,830 miles. A little more than a week later, the *Skate* left New London, Connecticut, and duplicated the polar feat of the *Nautilus*. The cigar-shaped *Skate* conducted under-ice explorations near the Pole before returning to its New London base.

Meanwhile, a third nuclear-powered sub, the *Seawolf*, was conducting experiments in the Atlantic. The purpose: to find out how crew members are affected by long periods under the water. The U.S. now has eight atomic submarines in operation.

From a military standpoint, the voyages of the *Nautilus* and *Skate* are of great importance.

Radiation level too high?

Man may already be getting a dangerous amount of radiation. This is the sobering conclusion of a long-awaited United Nations report.

The UN report points out that radioactive fall-out from nuclear tests is only a small part of the total radiation we are exposed to. Most radiation comes from natural sources. This radiation may be at a level that already threatens human health, said the report. Additional doses from nuclear-test fall-out could harm both present and future generations. Among other things, too much radiation can shorten life, cause the blood disease of leukemia, and result in the birth of physically deformed or mentally retarded children.

UN scientists who prepared the report were nearly unanimous in their opinion that nuclear tests should be stopped. But to avoid politics they didn't call for a halt to such tests.

The UN report has been in preparation for the past two and a half years. It drew praise from the U.S. Atomic Energy Commission as "a thoroughgoing scientific study."

—U. P. I., Inc.

Wickie, the space mouse, rode 6,000 miles in nose cone of Air Force rocket. Since cone was not recovered, no one knows how tiny rodent reacted to trip.

Anti-radiation pill

A pill to guard against harmful effects of atomic radiation may soon be tested on humans. The pill is made from a compound called AET.

So far, AET has been given only to animals. It protected them from what should have been a killing dose of radiation.

But what's good for animals isn't necessarily good for people. In humans, AET causes undesirable side-effects, such as nausea and a lowering of blood pressure. It may, in fact, be poisonous to man. AET has another drawback: it must be taken within an hour before exposure to radiation. Otherwise it loses effectiveness. If the pill is to be useful, scientists must improve it.

Another possible bright spot in the radiation picture has appeared. Scientists think it may be possible to find a way to *undo* radiation damage to human germ cells. Up to now, everyone has taken for granted that such damage couldn't be repaired. Germ cells are the agents that transmit hereditary traits from one generation to another. Radiation damage to these cells can cause harmful defects in newborn babies.

Clue to photosynthesis

A vitamin seems to play a vital role in the intriguing mystery of photosynthesis. It is vitamin K, the same substance necessary for coagulation (thickening) of the blood.

Photosynthesis is the process in which green plants manufacture food for themselves. But photosynthesis has another, equally important function. It maintains a constant supply of oxygen for the earth's atmosphere.

Aided by the sun's energy, a green plant splits water into its two components, hydrogen and oxygen. It then combines hydrogen with carbon dioxide from the atmosphere. This action produces sugars and starches. The energy of sunlight is stored in them as chemical energy, ready to be used by all living things. Finally, the oxygen that has been split from the water is let loose into the atmosphere. This keeps the oxygen content in the air constant.

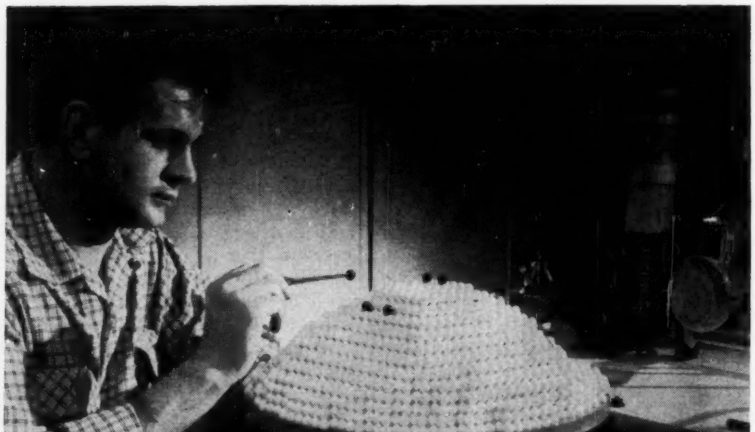
With the help of radioactive carbon dioxide, scientists have learned much about photosynthesis. But the big puzzle remains: how is the energy of sunlight snared in the plant's chemical "trap" — the green pigment, chlorophyll?

As a result of experiments at the University of Chicago, one more piece of the puzzle has fallen into place: vitamin K apparently acts as a chemical catalyst to promote photosynthesis. It is present in the chloroplasts, the green particles in chlorophyll. In the experiments, chloroplasts were isolated from spinach leaves. The vitamin K was removed from the chloroplasts. They were then unable to perform the complex photosynthetic action. But when vitamin K was added, the action again took place.

Weather and behavior

Why is it easier to lose your temper at one time than at another? Scientists are trying to find out if the weather plays a part in determining human behavior. Evidence gathered at the American Institute of Medical Climatology shows that it may. The number of deaths, accidents, murders, suicides, and other clues to human emotions, for example, are not distributed evenly throughout the year. Instead, they show ups and downs.

Scientists are attempting to determine whether these ups and downs are connected with such weather conditions as sudden drops in barometic pressure and in temperature, unseasonal winds, and high humidity and temperatures. One theory holds that positive or negative ions in the air influence the way we feel and act. These electrically charged particles are created when an atom or molecule gains or loses an electron. Negative ions are thought to produce good effects on human beings; positive ions, bad effects. There is evidence, for example, that negative ions can relieve pain in man and give him a feeling of well-being. But researchers haven't been able to find out why this is so.



—Union Carbide

Beehive? No, this is how the tip of a sharp tungsten needle would look magnified 100 million times. Model is for study of catalysts, which speed chemical reactions.

News in brief

• The skeleton of a manlike creature believed to be about ten million years old has been found. The four-foot skeleton turned up in a coal mine in the mountains of northern Italy. Its discovery may cause anthropologists to change their opinions on the length of time man has existed. Until now, they have believed man to be no more than one million years old.

• Choosing a career early apparently pays off in dollars and cents. This was indicated by a survey of New York University alumni (classes of 1946, 1951, and 1956). Here are the average monthly earnings of graduates, broken down according to when they made their career decisions: first year of college — $650; second year — $580; third year — $565; fourth year — $550; after graduation — $530.

• Some people take in much more radioactivity from food than from atomic-bomb fall-out. This conclusion stems from a study by British scientists. They found that foods vary widely in their natural radioactive content. Brazil nuts are far and away the most radioactive food. Second and third are cereals and shellfish. Foods found to be the least radioactive were fruits and vegetables. One point that the scientists emphasized: there's no evidence that eating any of these foods has harmed anyone.

• The first unmanned rockets to land on the moon may "contaminate" that body, two scientists warn. A rocket may carry with it micro-organisms from the earth. By the time scientists got samples of the moon's surface, it would be hard to tell whether any existing life was formed on the moon or on the earth. How to prevent such contamination? Sterilize moon rockets.

• The case of the disappearing water-birds is worrying wildlife conservationists. Flocks of ducks, geese, and herons are leaving the U.S. for points north and south. Reason: swamps and wetlands where they live are fast being drained to provide land for expanding cities and industry.

• "Seasick" missiles will soon be launched from Cape Canaveral, Florida. A new device there pitches, heaves, and rolls like a ship. Its purpose: to flight-test the Navy's solid-fuel Polaris missile. The Polaris is designed to be launched from a submerged sub. The 1,500-mile missile will be used to arm atomic submarines.

Do automobile exhaust gases cause cancer?

The answer is not known. It is a matter of common scientific information that: (1) some tarlike substances made from crude petroleum (but not from gasoline) have stimulated cancerous growths when smeared on the ears of experimental rabbits; and (2) some statistics suggest that there is more lung cancer among people who

drive long hours in heavy city traffic than among drivers who don't. But there is no evidence to show that any specific substance in motor fuel is harmful. Nor is there evidence that the products of incomplete combustion are harmful. On the other hand, there is no proof that combustion gases are harmless, either. More research is needed.

Why does the surface of the ocean often seem to change in color? Why does it look blue in some places and green in others?

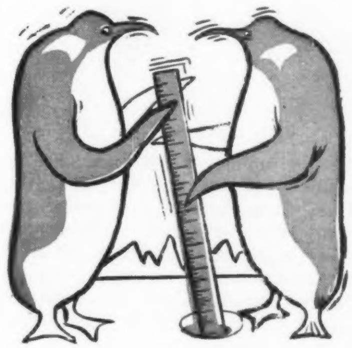
The surface of the sea reflects the light that falls upon it. On a clear day when the sky is deep blue, the water looks blue, too. On a hazy day, the color is a greenish gray. On a dark, stormy day, the water is often a dull gray. In general, tropical seas are blue and arctic seas are green. The reason: the sky is more often blue in the tropics, while in colder regions clouds and fog are more usual.

But the color you see when you look down into or through the water is another matter. Clean sea water absorbs the red and orange portions of the white sunlight, but is more transparent to blue light. So the underwater color is blue. When the water contains fine sediment or microscopic forms of life, its color will vary according to its content. In much the same way the color of the sky is affected by dust particles in the air. Even the bluest water looks green when breaking waves fill it with small air bubbles. Most water near shore is likely to look green because of sediment, microscopic life, or foam.

How much ice is there in Antarctica?

The average thickness of the ice measured during the International Geophysical Year is about 8,000 feet. The area of Antarctica is more than five million square miles. Thus the total ice volume, as known to date, is about eight million cubic miles. If all the ice were to melt, it would raise ocean levels everywhere on the globe by 200 feet.

The thickest ice, 14,000 feet, was found in Marie Byrd Land, on the western side of the continent. In more than two-thirds of this area the ice extends far below sea level. At one point, where the altitude of the icy surface is 4,626 feet, the ice is 10,826 feet thick. It thus extends 6,200 feet below sea level. The mountains along the near Pacific shore, eastward from Little America, now seem to form an



archipelago separated from the continent by a wide and deep ice-filled strait. In most of east Antarctica, however, the rock surface is several thousand feet above sea level. It is covered with more than a mile of ice. At the South Pole the altitude is 9,200 feet. The ice there is 8,300 feet thick, and the rock base is 900 feet above sea level.

What is the cost of atomic power?

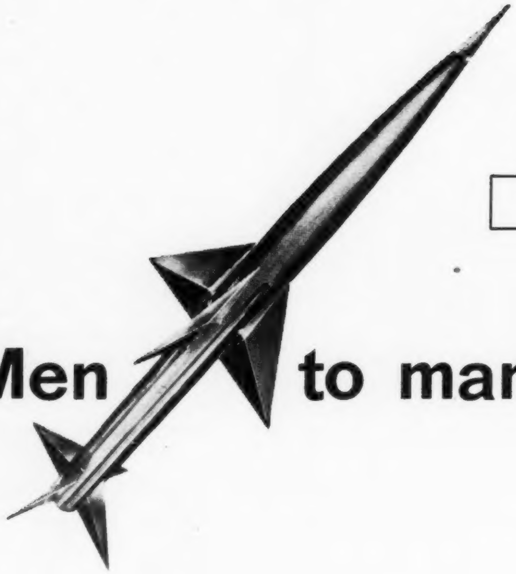
The only American commercial plant to produce electric power from uranium fuel is in Shippingport, Pennsylvania. Electric power produced here costs about 65 mills per kilowatt hour. (A mill is a tenth of a cent.) The cost of producing electric power from cheap natural gas is about 5 mills; from coal, 7 or 8 mills.

— Gerald Wendt

Questions from readers will be answered here, as space permits. Send to: Question Box, Science World, 575 Madison Avenue, New York 22, N.Y.

Drawings by Jack Woolhiser

Careers



Men to man the missiles

In the summer of 1948 a handful of scientists and engineers from the Sperry Gyroscope Company arrived at Point Mugu, a small, isolated U.S. Navy outpost on a desolate stretch of the California coast. By 1950 the lonely outpost was beginning to mushroom into a huge, sprawling installation, bristling with electronics equipment and swarming with sailors and marines. The handful of Sperry men increased until there were eventually more than one hundred. Their objective: to test the flight performance of Sperry's air-to-air missile, the Sparrow I. The Sparrow was designed to be launched from a carrier-based plane. Its job: to knock an enemy aircraft out of the sky with one lethal punch.

One of the Sperry men who arrived at Point Mugu in early 1950 was David Kahl. He had just joined the company after getting his electronics engineering degree from the University of California. When David arrived, the Sparrow was strictly an experimental weapon. Its effectiveness and reliability were still to be proven. When he left five years later, the Sparrow was the standard and highly respected weapon of the Navy's carrier-based fighters.

David Kahl's role in this achievement was not a small one. During his five years at Point Mugu, he worked on almost every aspect of the Sparrow's development: testing and evaluating its electronic components, devising modifications, preparing the missile for "live" firings.

The Sparrow, David explains, is called a "beam rider" because it flies along a radar beam from the launching plane to the target. When the pilot presses the firing button, electricity ignites the missile's rocket motor, and the missile leaps forward into the air. In a few seconds the Sparrow's radar receiver picks up the radar beam. The missile is now traveling about 1,500 miles per hour. If the Sparrow strays from the beam, electronic computers connected to its radar receiver feed corrections to control surfaces. The missile veers back on course.

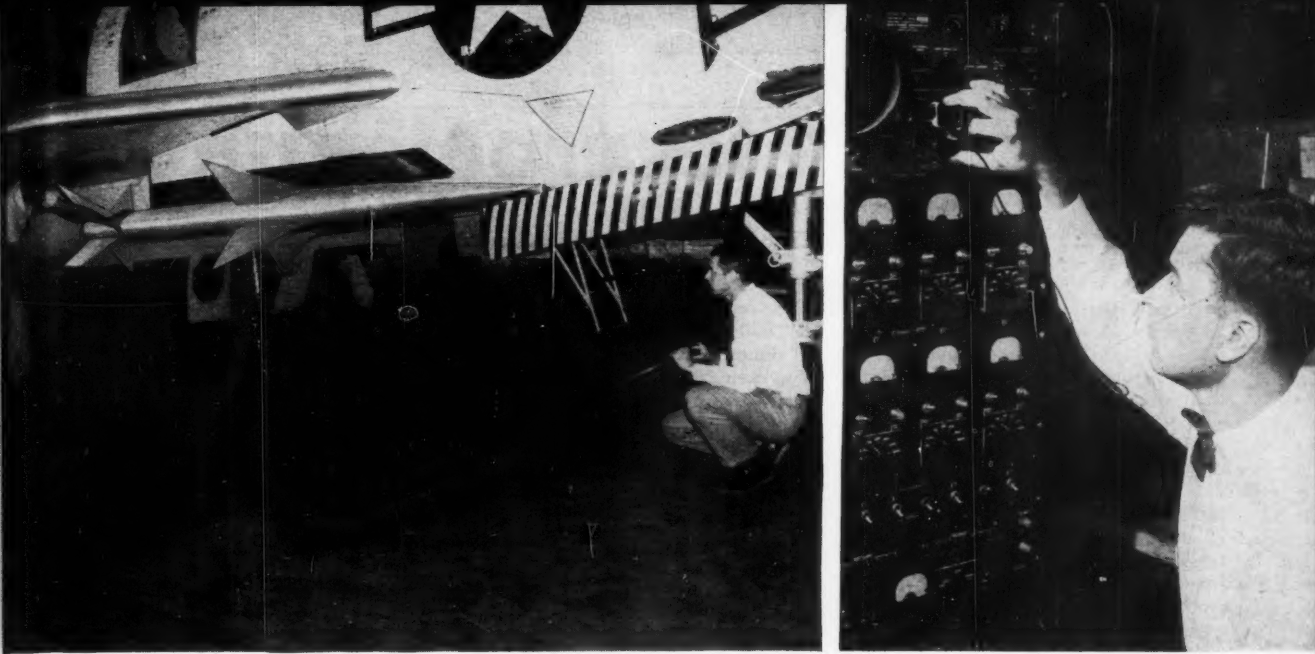
Probably David's most dramatic — and dangerous — moments at Point Mugu were spent in the co-pilot's seat of a Sparrow-armed Navy jet. As missile-launching engineer, he had to check the operation of the guidance radar and observe Sparrows streaking toward and destroying target drones. On one early flight the stabilizer fins of a Sparrow ripped off seconds after firing. The missile swerved in the air and began to break apart. Bits and pieces rained past the plane. Fortunately, none hit a vital spot. But Sperry technicians, after listening to David's report, made sure that the next test Sparrow would *not* lose its stabilizers.

Like most engineers in missile test and evaluation work, David was expected to do things that had little bearing on his specialty, electronics engineering. "I had to double at every job at Point Mugu," David says. Naturally, much of his work involved the radar and other electronic elements of the Sparrow. But he also had to have a working knowledge of aerodynamic and mechanical engineering to be able to determine the causes of defects in the missile. And he had to be an expert cameraman. Finally, David was responsible for the work of a group of technicians and junior engineers. His problems were administrative as well as technical.

David thrived on his various jobs and responsibilities. "I kept poking my nose into different laboratories," he says, "and pretty soon I would find myself facing a new problem, a new challenge." His initiative and capability led to rapid promotions.

David's scientific curiosity has always been just as free-wheeling and energetic. In high school he divided his afternoons and evenings between doing his homework and operating his own amateur radio station. Then, while working full-time as a radio technician, he completed courses leading to an electronics degree.

David is now an engineering supervisor at Sperry Gyroscope Company headquarters in Great Neck, New York, working on another important military project: countermeasures for the U.S. Air Force. Broadly speaking,



— Sperry Gyroscope Co.

LETHAL MISSILE, the Sparrow, is slung beneath fighter plane. Engineer who helped prove missile's worth is David Kahl (right).

a countermeasure is any method of jamming an enemy's radar. One way to do this is for a U.S. bomber to transmit a signal on the same frequency as the enemy's radar. This obscures any object on the enemy's radarscope. But that's an old trick, and there's little doubt that an enemy could develop a way to "see" through it. More ingenious and more foolproof countermeasures must be developed. These are the top-secret devices that presently concern David Kahl.

It's difficult to guess what kinds of missiles will be under development five to ten years from now, when many of today's high school students will become engineering graduates. The missiles of 1963 and beyond will certainly be radically different from the Sparrow, the Jupiter, and the Atlas missiles of today. Engineers will be facing more advanced problems — problems that may make the work on the Sparrow seem as basic as two plus two. That's how fast missile engineering is moving. It's also why missile work is and will continue to be one of the most exciting and challenging jobs in industry.

But certain predictions *can* be made. The military services will still be contracting with private companies to build missiles as war deterrents or for space exploration. And private companies will still be looking for top-notch engineering graduates to man their missile programs. It's fairly certain, too, that electronics, mechanical, and aerodynamic engineers will be most in demand for missile work.

Here are some facts to help you decide what the missile field might hold for you:

What natural interests and abilities should you have?

The same ones any potential engineer should have: an aptitude for math and science, an ability to express your ideas, an interest in all kinds of mechanisms, and a desire to get to the bottom of any mechanical problem. Finally, you must be able to work as a member of a team.

Is there any way of telling now whether you would like the work?

Your reaction to a physics course could be a good indicator. If you are interested and do well in it, chances are you've got at least the spark of a missile engineer in you. If you like working with radio or TV sets, you might well set your sights on the electronic aspects of missile work. A surprising percentage of missile engineers were once amateur radio operators.

Where should you go to college?

Any school that offers a top-notch engineering course. If you know any engineers, ask them which colleges are respected by their companies — and which colleges' graduates are most sought after by industry.

Should you do postgraduate work?

It's not an absolute necessity. If a company thinks one of its engineers should have special training in a new field, the company will usually arrange to train him. Men with advanced engineering degrees are more generally found in research and development labs than in an industrial concern.

What about women's chances in the field?

Sperry officials feel that women can handle the early phases of missile engineering — component design and theoretical work — as well as or better than most men. There are women engineers in Sperry's Great Neck (New York) plant. However, the more hazardous test and evaluation phases are always restricted to men.

What are your chances of stepping into missile work?

Industry's demand for engineers — and this includes those qualified to work on missile programs — seems to go in cycles. Right now some engineering graduates with below-average grades are finding it difficult to land the kinds of jobs they want. Two years ago a graduate could practically set his own terms. There's no telling how the situation will change in the next few years, but the trend appears to be toward an increased demand for missile men. Your best bet is to choose a specialty that will be valuable in missile work. A beginning engineer with top grades can earn anywhere from $5,500 to $7,000 per year in a missile program. — E. H. HARVEY JR.

Young scientists

An electromagnetic

Sometimes the best projects are those in which a simple principle is applied in a novel way. One such project was developed by Bob Benjamin of Yonkers (N.Y.) High School.

Bob had been reading about electromagnets. He knew the usual electromagnet consists of a coil of wire wrapped around an iron bar. When an electric current is passed through the wire, the iron becomes magnetized. Bob became particularly interested in the hollow-core electromagnet — that is, a coil of wire without an iron core. He was struck by the fact that such a coil, when carrying an electric current, will "suck" into its hollow core a piece of iron or steel.

Germ of an idea

He decided to experiment with this phenomenon. As an electromagnet, he used a solenoid coil from a discarded door chime. Sending current through this coil, he studied its action on a nail. During these experiments the germ of an idea began to form.

To pursue his idea he constructed the simple model shown in Figure 1. He used a piece of glass tubing about 6 inches long, some No. 26 double-cotton-covered (D.C.C.) wire, a dry cell battery, a push button, and a nail. He cut the nailhead off to allow the nail to slide freely through the glass tube. About 3 inches from one end of the tube he wound 50 turns of wire, making a solenoid coil about 3/4 inch long. He set the nail in the tube just back of the coil and attached the coil through the push button to the battery. When he pushed the button, current flowed through the electromagnet. The nail moved forward, quivered, and centered itself within the coil.

But something more interesting happened when he pressed the push button momentarily and then released it. The nail shot out the other end of the glass tube. He realized why this happened: the electromagnet pulled the nail forward, but was shut off before the nail's momentum could be stopped.

Then came the big idea. If one electromagnet could start the nail forward, wouldn't a second electromagnet increase the nail's speed? What about a third and fourth? Could each electromagnet be positioned to increase the speed of the nail passing through it?

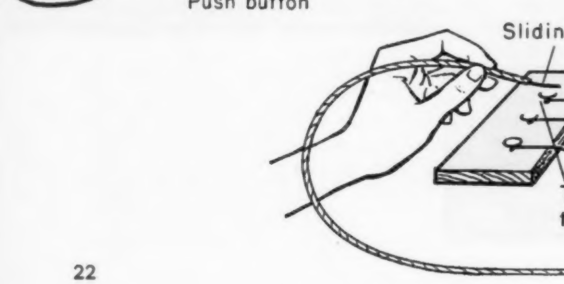
To answer these questions Bob made a second model (Figure 2), using three electromagnetic coils. The electrical contact for each was one of three thumbtacks on a board. By moving a contact wire rapidly along the board across the heads of the thumbtacks, Bob could momentarily energize each coil in turn. He experimented to find the proper timing for making the contacts. He also slid the coils to different positions along the tube to determine where they were most effective. The model was a success. The additional electromagnets increased the nail's speed. Further experiments showed that a twist drill bit made of a good-grade steel worked better as a projectile than did the nail.

Now he began to use his imagination. What was the limit to which the projectile could be speeded? What application of practical value could be made of this electromagnetic principle? He could answer the first question only by further experimentation. As for the second, he hit on the idea of an electromagnetic rocket launcher. This would be the theme of his science project — a new method of launching rockets that would conserve their fuel supply for later use.

For his project Bob decided to use five coils and a glass tube 18 inches long. He selected a twist drill bit that fitted loosely in the tube, filled the bit's flutings with plastic material, and painted it to resemble a rocket. Then he turned his attention to a timing device for energizing the electromagnets in the proper order and at the right time.

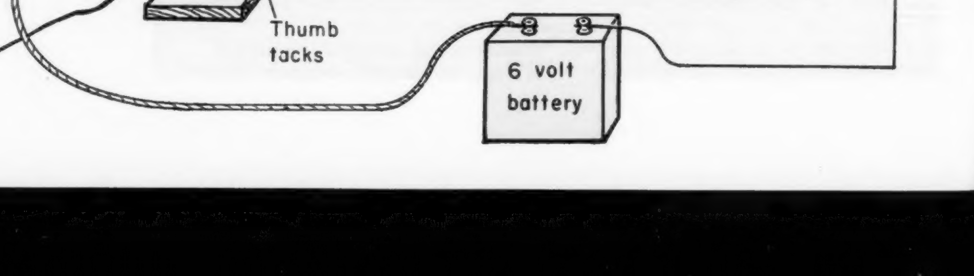
He realized that making the five contacts by hand was too much of a hit-or-miss affair. A multiple-contact rotary switch would solve the timing problem, particularly if it were operated by a slow-turning motor. Why not a phonograph motor? He found one in a local electrical supply house, along with a ten-contact rotary wafer switch. These were assembled as shown in Figure 3 on a board large enough to hold the entire project. A piece of flattened metal rod fitted to the rotary switch served as a shaft, which was

FIG. 1 First experimental model



Drawings by Mildred Waltrip

FIG. 2 Pilot model, used to determine timing and spacing of coils



rocket launcher

coupled to the phonograph motor. The timing mechanism was complete.

The launching mechanism was next. On the glass tube Bob wound five coils, each composed of 50 turns of No. 26 D.C.C. wire (Figure 4). He made each coil about 3/4 inch long. Fiber washers held the coils in place. From previous experience Bob knew that he should place the coils farther apart as they neared the launching tube's exit. The tube was set upright in a hole drilled in a 2-inch block of wood. A stiff, heavy copper wire was mounted parallel to the tube. One lead from each of the coils was soldered to the wire, which in turn was wired through a push button to one terminal of the battery. The other lead of each coil was wired to the proper contact on the rotary switch so that each coil could be energized in turn, starting from the bottom up. A wire from the common terminal of the rotary switch to the battery completed the circuit. Five contacts on the switch were unused, but this provided a lapse time between launchings.

The project was now almost complete. The phonograph motor was set turning by connecting it to a 110-volt line. When the button was pushed, closing the launching circuit, the projectile moved rapidly up the tube and shot out. Bob found that he did not have to time his pushing of the button to the position of the rotary switch, since the projectile started up only when the first electromagnet was energized. By experimenting, he found the best position for each of the coils. Soon he was able to shoot his rocket about ten feet into the air. Though the velocity of his projectile was not high, he was careful to see that no one was in the line of fire.

Now he had to think of preparing his exhibit for the local science fair. It wouldn't do to have the projectile shoot out at the fair, where it might get lost, so he closed over the top of the glass tube with a metallic bumper. When he found that the wood at the base of the tube was being pounded by the projectile when it fell back, he inserted a flat piece of aluminum. Now when he pressed the launching button and held it, the projectile rose, struck the top, fell back, and awaited the next launching cycle. It continued to move up and down like a trip hammer.

Details of exhibit

The project was now ready to be exhibited, but needed explanatory material. He chose to prepare three panels, two on each side and a larger one in between. On the larger center panel the title of the project was lettered neatly and clearly. Below, with the aid of diagrams, he explained the project's purpose. On the right-hand panel he outlined the circuits and details of construction. On the left-hand panel he explained and illustrated the applications of the principle, tying them to the rocket experiments at Cape Canaveral. [*Continued on p. 28*]

TELL US ABOUT IT

Have you done an interesting science project? If so, tell us about it. We will pay $15 for any student project submitted by an SW reader and published in "Young Scientists." The description of your project may be typewritten or legibly handwritten. It should be accompanied by any necessary illustrations, as well as the written approval and signature of your teacher. Publication in SCIENCE WORLD in no way interferes with your right to use the project elsewhere. We regret that no contribution can be acknowledged or returned. Send to: Science Project Editor, Science World, 575 Madison Ave., New York 22, N. Y.

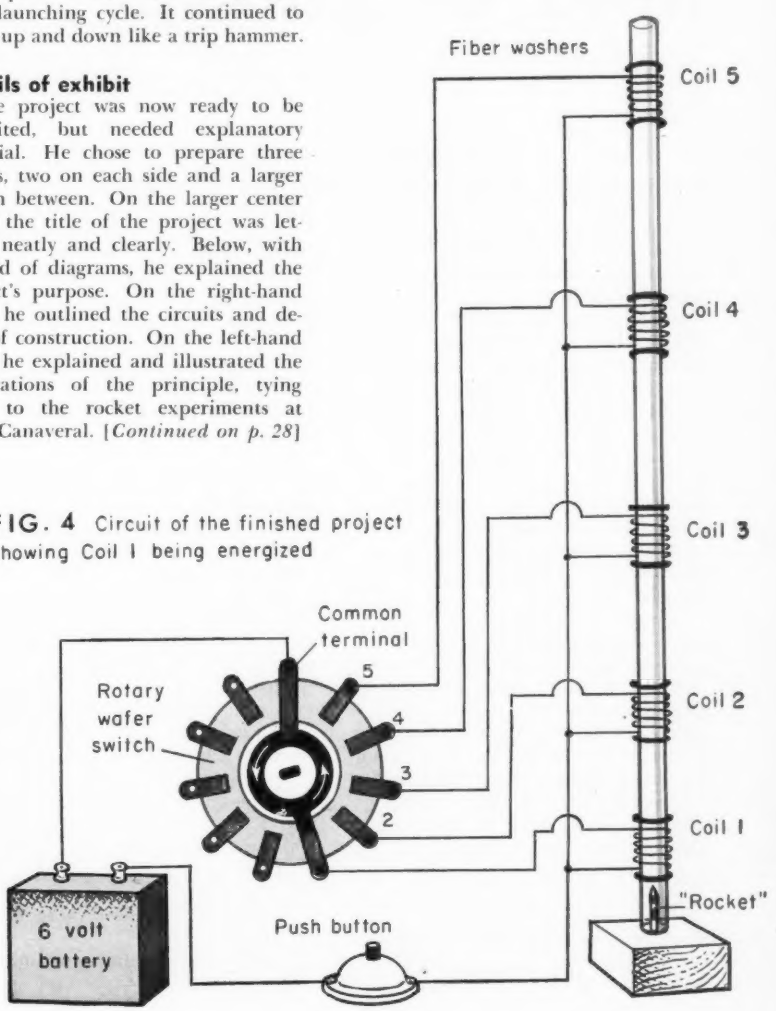


FIG. 4 Circuit of the finished project showing Coil I being energized

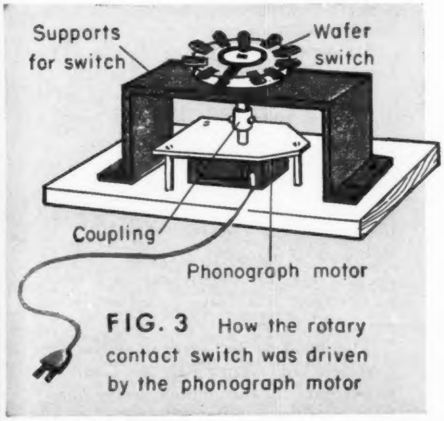
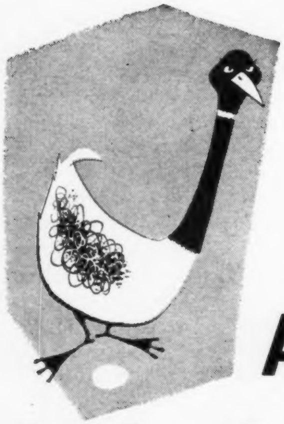


FIG. 3 How the rotary contact switch was driven by the phonograph motor



By Isaac Asimov

A very special kind of goose

It was only a goose, but it drew scientists and armed guards in droves to the Texas farm

I couldn't tell you my real name if I wanted to, and under the circumstances I don't want to.

I'm not much of a writer myself, so I'm having Isaac Asimov write this up for me. I've picked him because he's a biochemist, so he understands what I tell him. Besides, he writes science fiction and that is very important.

I wasn't the first person to have the honor of meeting The Goose. That honor belongs to a Texas cotton farmer named Ian Angus MacGregor (I'm using fictitious names, of course), who owned it before it became Government property.

By summer of 1957 he'd sent a dozen letters to the Department of Agriculture requesting information on the hatching of goose eggs. The Department sent him all the information it could, but he kept wanting more. I'm in the employ of the Department and I was attending a convention in San Antonio in July of 1957, so my boss asked me to stop off at MacGregor's place and see what I could do.

So it was that on July 17, 1957, I met The Goose.

I met MacGregor first. He was in his fifties, a tall man with a lined face full of suspicion. I went over all the information he'd been requesting, then asked politely if I might see his geese.

He said: "It's not geese, mister, it's one goose."

I said: "If it's only one goose, what's your worry? Kill it and eat it." I got up and reached for my hat.

He said, "Wait!" and I stood there while he hesitated. Then he muttered, "Come with me."

I went out with him to a pen near the house. The pen, surrounded by barbed wire, with a locked gate to it, held only one goose.

"That's The Goose," he said. I could hear the capitals as he spoke.

It looked like any other goose: fat, self-satisfied, short-tempered.

MacGregor said: "And here's one of its eggs. It won't hatch." He produced the egg from a capacious overalls pocket, letting it lie on the palm of his hand. It was smaller and rounder than a goose's egg ought to be.

MacGregor said: "Take it."

I reached out and took it. Or tried to. I had to try harder, and then up it came. It weighed nearly two pounds!

MacGregor grinned sourly. "Drop it," he said.

I just looked at him. So he dropped it himself.

It hit soggy. It didn't smash. There was no spray of white and yolk. It just lay where it fell, with the bottom caved in.

I picked it up again. The white eggshell had shattered where the egg had struck. Pieces of it had flaked away and what shone through was a dull yellow in color.

My hands trembled. It was all I could do to make my fingers work, but I got some of the rest of the shell flaked away and stared at the yellow.

I didn't have to run any analyses. My heart told me.

This was The Goose That Laid the Golden Eggs!

My first problem was to get MacGregor to give up that golden egg.

I said: "I'll give you a receipt. I'll guarantee payment. I'll give you a personal check. I'll do anything."

"I don't want the Government butting in," he said stubbornly.

I was twice as stubborn. I followed him about. I pleaded. I yelled. In the end I signed a receipt and he dogged me out to my car and stood in the road as I drove away, following me with his eyes.

The head of my section at the Department of Agriculture is Louis P. Bronstein. (False names, remember.) I laid the egg on the desk between us.

I said: "It's a yellow metal and it

This story appeared in the pilot issue of SW. It is reprinted here by popular request. Adapted by the

Illustrated by Paul Granger

Science fiction

could be brass. Only it isn't, because it's inert to concentrated nitric acid."

Bronstein said: "It's some sort of hoax. It *must* be."

"A hoax that uses real gold? When I first saw this thing it was covered completely with authentic unbroken eggshell. I analyzed a bit and it was calcium carbonate."

So Project Goose was started. That was July 20, 1957.

I was the responsible investigator at the start, though matters quickly got beyond me.

To begin with, the egg had a radius of thirty-five millimeters on the average. The gold shell was just about two and a half millimeters thick. Inside was a real egg; it was no hoax. It contained all the proteins, fats, vitamins, and pigments one would expect.

The only important abnormality that showed up at once was the egg's behavior on being heated. A small portion of it hard-boiled at once.

Boris W. Finley of Temple University, a Department consultant, said: "The proteins are obviously in bad shape, and it must be the fault of the gold. Small quantities of any heavy metal break down protein."

So the yolk was analyzed for gold. And, sure enough, it contained just about one-third of 1 per cent of gold in a soluble form known as chloroaurate.

As for the shell, that was virtually pure gold. The only detectable impurity was iron, and that amounted to only about one-fourth of 1 per cent. The iron content of the egg yolk was twice as high as it should have been, too. But at the moment the matter of the iron was neglected.

One week after Project Goose was begun the first expedition left for Texas. Five biochemists went, along with three truckloads of equipment and a squadron of Army personnel.

As soon as we arrived we cut MacGregor's off from the world. Naturally, MacGregor didn't like all the security regulations and all the men and equipment settling down all about him. He didn't like being told that The Goose and its eggs were Government property. He didn't like it, but he had to agree. What could he do? He was compensated, of course.

The Goose didn't like a few things, either — like having blood samples taken. It took two men to hold The Goose each time.

The blood of The Goose was put through every test conceivable. It contained two-thousandths of 1 per cent of the chloroaurate I've mentioned. We took X rays. Parts of the body that were rich in gold would stop the X rays and appear white on the negative. The liver showed up as light gray, while The Goose's egg-laying apparatus was pure white.

Finley said: "The chloroaurate is passed into the bloodstream by the liver. It's poisonous, so the blood passes it on to the reproductive organs, which get rid of it by making eggshells out of it. That kills the eggs but keeps The Goose alive."

He paused and said: "That leaves one embarrassing question."

I knew what it was. We all did.

Where was the gold in the liver coming from?

There was no answer to that for a while. There was no gold in The Goose's feed, of course, nor any gold in the soil to speak of. A search of the grounds revealed nothing.

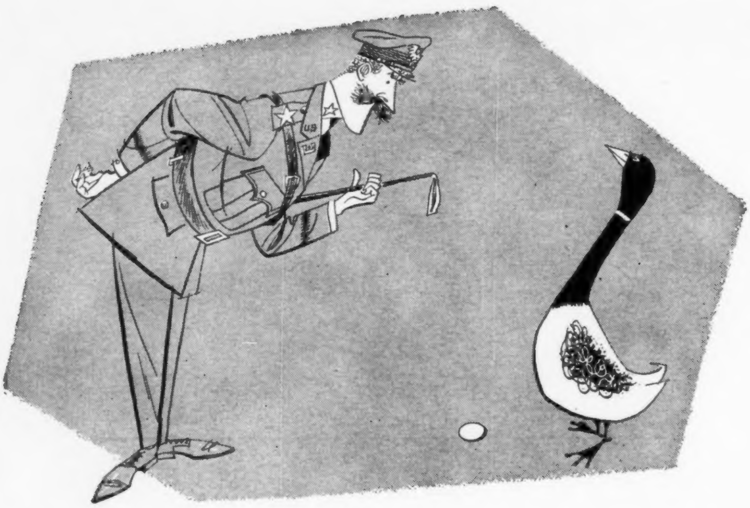
On August 16, 1957, Albert Nevis of Purdue got the first lead. He was studying the stomach contents of The Goose by using tubes that he forced down its throat.

He came rushing to us. "The Goose is practically zero on bile pigment!" he shouted.

Let me explain something at this point. Bile pigments are colored materials that are contained in the juice the liver pours out into the intestines. The pigments are produced by the breakdown of hemoglobin, which is the red coloring matter of blood.

Finley's eyes began to glitter. This was the first sign of anything wrong

author from a story that originally appeared in Astounding Science Fiction. *Copyright Street & Smith.*



with the chemistry of The Goose, other than the gold. He stated the obvious. "There must be something wrong with the hemoglobin or with the liver's machinery for handling hemoglobin."

Promptly we took more blood samples. This time we separated the hemoglobin out of the blood in the usual dark red crystals. However, further treatment separated a small quantity of a bright orange substance.

It turned out to be similar to hemoglobin but *not* hemoglobin. Ordinary hemoglobin contains an iron atom in its molecule. This contained a gold atom.

The liver, it seemed, was not breaking up the hemoglobin to bile pigment. Instead, it was changing some of the hemoglobin to the gold-containing variety and getting rid of it by way of eggshell.

We tried injecting The Goose with solutions containing radioactive gold, to see if we could learn the exact route traveled by gold atoms in its body. But the experiment failed.

This still left us with the question of where the gold came from, and it was Nevis who first made the crucial suggestion.

"Maybe," he said, at a meeting on August 25, 1957, "The Goose changes the iron into gold by transmutation."

Maybe he wasn't serious when he said that, but we were so desperate we had to take him seriously.

On September 5, 1957, John L. Billings of the University of California, one of the country's best nuclear physicists, arrived. He had some equipment with him, and more arrived in the following weeks. I could see that within a year we would have a whole research institution built around The Goose.

Finley brought Billings up to date and said: "The trouble with the iron-to-gold idea is, for one thing, that the total quantity of iron in The Goose is only about half a gram; yet nearly forty grams of gold a day are being manufactured."

Billings had a clear, high-pitched voice. He said: "There's a worse problem than that. The nucleus of the gold atom contains much more energy than the nucleus of the iron atom. To manufacture all the gold The Goose does would take an atom bomb's worth of energy."

But he got right to work. He isolated some of the iron from the hemoglobin of The Goose and, among other things, ran an isotopic analysis on it. The result nearly choked him.

He said: "There's no iron 56."

Let me explain again. Most elements are made up of a variety of closely similar atoms called isotopes. Iron contains four different isotopes, of which the most abundant is iron 56. Well, that one was missing; the other three were there.

Billings said: "There must be a nuclear reaction going on in The Goose, but where is it getting the energy?"

We didn't see Billings for two days.

When he came back he said: "See here. There are two parts to this reaction. First, some simple isotope must be converted to iron 56. That's a type of reaction that produces energy. Then the energy produced is used immediately to change the iron 56 into gold. It's like going down one side of a roller coaster and up the other. And there's enough oxygen 18 in the body to supply all the gold The Goose produces."

We could check that theory. You see, oxygen 18 is one of the minor oxygen isotopes. It's easy to get samples of water containing more oxygen 18 than normal water does.

We fed The Goose on water with high oxygen-18 content for a week. Gold production went up.

"There's no doubt about it," said Billings. He stood up. "That Goose is a living nuclear reactor."

The Goose was obviously a mutation, a sport — a creature that had had a different chemistry from birth. The best guess was that it was the result of radiation. Nuclear tests conducted in 1954 and 1955 had resulted in fall-outs passing near MacGregor's farm. We checked the records. The Goose had been born shortly after one of the fall-outs.

"What it amounts to," said Billings, "is that The Goose can convert any radioactive isotope into a stable one. It has developed the perfect defense against radiation sickness."

We tried gamma rays on The Goose. It developed a slight fever and got more bad-tempered than usual, but nothing else.

Finley said: "It's the creature of the future. If only human beings could develop such defenses, atomic war would lose some of its terrors."

Billings said: "Not only that. If we could find out how The Goose does it and duplicate it in industry we'd have the perfect way of disposing of radioactive ash from nuclear power plants."

We sat there, all of us, staring at The Goose and thinking of the secret in its liver.

We couldn't remove the liver for study. Who would dare kill The Goose That Lays the Golden Eggs? If we could only *hatch* some of those eggs!

Nevis said: "We need some good idea."

In a miserable attempt at a joke I said: "We could advertise in the newspapers." And that gave *me* an idea. I said excitedly: "We could write this up as a science-fiction story."

They stared at me.

"Why not?" I said. "We wouldn't be breaking security regulations. No one would take it seriously. And we might ask for ideas. Don't underrate science-fiction readers. What can we lose?"

They were unmoved.

So I said, "And you know, The Goose won't live forever."

That did it. And this is the story.

Now — how can we study The Goose without killing it? How can we hatch the eggs and get more gold-laying geese?

Any ideas?

Announcing the United States Army's Graduate Specialist Program 1958 ~ 1959

The Purpose: This program is offered to provide qualified high school graduates with the technical schooling which will enable them to join the Army's key group of specialists, its select team of experts in every field from electronics to rocketry and guided missiles.

The Program: This plan offers young men their choice of 107 technical training courses—young women, their choice of 26. These courses are conducted at special Army schools which utilize the most modern technical facilities and equipment available. All instructors are experts in their fields. Completion of schooling qualifies young men and women as skilled specialists—ready to begin careers in their chosen specialties.

The Qualifications: To qualify as a Graduate Specialist, you must pass certain qualification and aptitude tests and be a high school graduate. However, you may apply while you are still in your senior year and, if qualified, enter the program after graduation. It is advisable to apply early, since quotas for each course are limited and qualified applicants are selected on a first-come-first-served basis.

The Procedure: To apply for the Graduate Specialist Program, visit your local Army Recruiting Station. Your Army Recruiter will give you an enlistment screening test. After passing this initial qualification test, you will be interviewed by the Recruiter who is an experienced counselor. He will discuss your academic background and interests with you. Based on your own abilities and desires, he will help you select a first choice course and two alternates. If quotas for your first choice course are filled, you may still become a Graduate Specialist in one of your selected alternates. Your Army Recruiter will then forward your application for processing. You will later receive a formal letter notifying you that a place in a course of your choice is waiting for you. Not until after high school graduation and shortly before your course begins will you actually enlist, and then only for three years. Before enlistment, you will take two final tests, the Armed Forces Qualification Test and the Army Qualification Battery. After making qualifying scores in these tests relating to your particular chosen field, you are ready to enlist as an Army Graduate Specialist.

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- Motion Picture Photography
- Neuropsychiatric Procedures
- Dental Laboratory
- Medical Laboratory Procedures
- Photographic Laboratory Operation

Yours for the asking

In *Selection of Engineering Training in the Field of Rockets, Jet Propulsion, and Astronautics*, the American Rocket Society answers the three questions most frequently asked by students interested in careers in rocketry: (1) in what engineering field should I specialize to best prepare for a future in rocketry, jet propulsion, or astronautics? (2) what elective courses should I choose? and (3) what factors should I consider in selecting an engineering school? Request from: American Rocket Society, 500 Fifth Ave., New York 36, N.Y.

Four booklets in the New York Life Insurance Company's career series should prove helpful to students who expect to go to college. *Should You Be a Chemist?* written by the late Dr. Irving Langmuir, Nobel Prize winner, discusses possibilities in the chemical field. *Should You Be an Engineer?* by T. Keith Glennan, president of Case Institute of Technology, offers a brief self-quiz for determining engineering aptitude. *Should You Be a Scientist?* by the famous nuclear scientist Dr. Edward Teller, lists essential personal qualifications for a career in any phase of science. *The Cost of a College Education* is a fifteen-page directory of more than 600 colleges and universities in the United States and Canada. It specifies tuition and fees and estimates living expenses. Write to: New York Life Insurance Co., 51 Madison Ave., New York 10, N.Y.

About the contributors

David Gunston, one of Britain's busiest feature writers, makes his initial appearance in *SW* this issue. Numerous articles on subjects in the physical and natural sciences have given him a large following in more than thirty countries, plus "a daily postbag of ever-growing hugeness."

Harry M. Schwalb is science editor of *The Laboratory*, a publication of the Fisher Scientific Company, in which "It's Not Just Water" first appeared.

SW's brand-new "Question Box" will be tended by Dr. Gerald Wendt, nationally known lecturer, science writer, and editor. Founder of *Science Illustrated*, Dr. Wendt has had a long science-editing career.

Globe-hopping author Roy A. Gallant departs from missiles and space travel to write about plants. With *Exploring Chemistry* and *Exploring the Planets* recently added to his fast increasing roster of published books, Mr. Gallant departs again — this time literally — for England, where he will work on (1) a book on geology and (2) sections of a young people's science encyclopedia.

Cover artist Lee Ames is well known in these offices (he illustrated Roy Gallant's *Exploring Chemistry* and *Exploring the Sun* and Editor-in-Chief Patricia Lauber's soon-to-be-published *The Quest of Galileo*). This issue's striking cover is his first for *SW*. A free-lancer for nearly twelve years, he is now with the art department of Garden City Books.

Edmund H. Harvey Jr. is a former *SW* staff member now working for a New York literary agent and doing free-lance writing.

Rocket launcher

(*Continued from p. 23*)

Though Bob didn't win the top prize at the science fair, he gained a measure of fame and much personal satisfaction. By diligent application of knowledge, ingenuity, and hard work, he had developed a simple principle into a fine project. Anyone can do the same and have a lot of fun in the process. Now is the time to start.

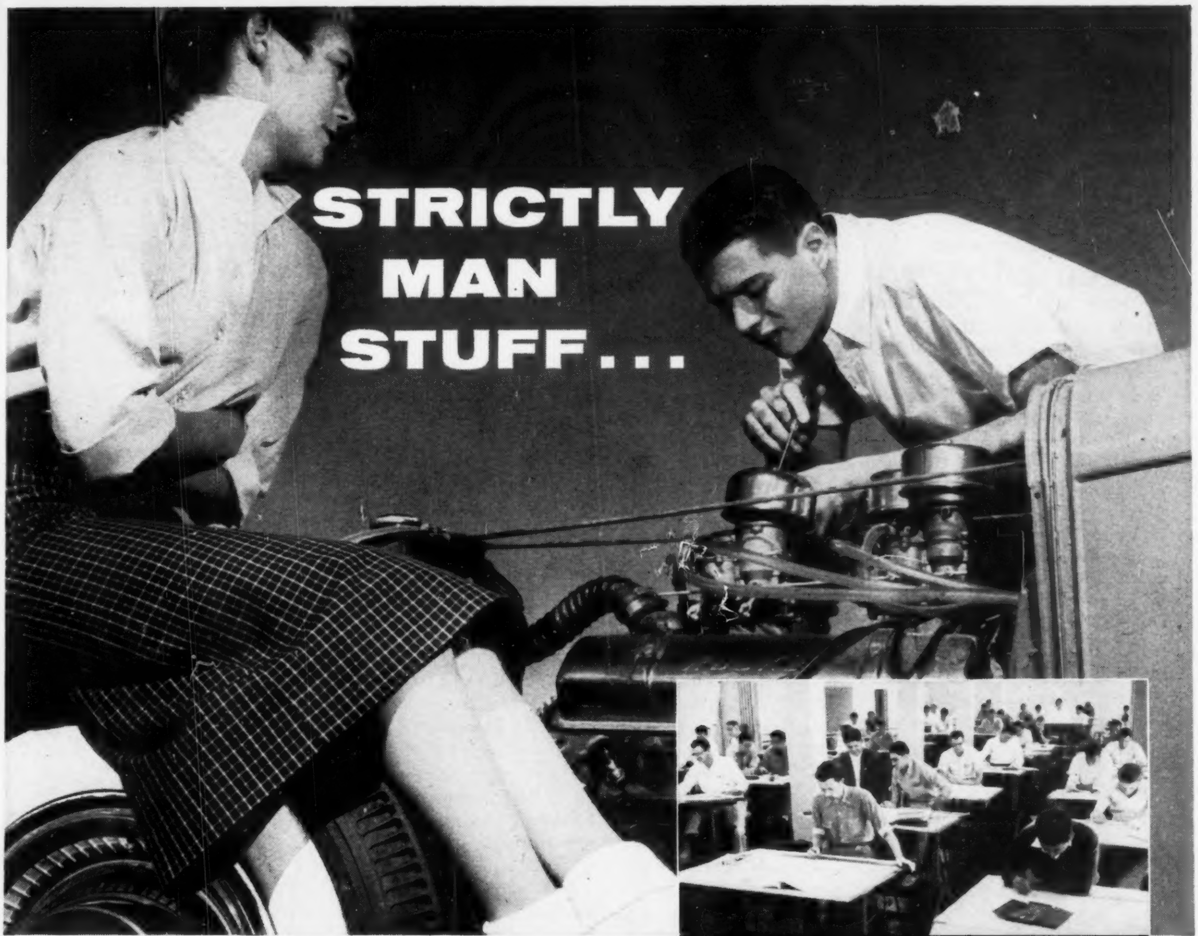
Growing plants without soil

A culture solution that will enable you to grow plants in clean sand, sawdust, or vermiculite can be a good starter for experiments in plant nutrition. Such a culture solution must contain six major elements — calcium, phosphorus, potassium, magnesium, nitrogen, and sulfur — and trace elements, including iron, boron, manganese, and zinc. These can be purchased in your local chemical supply house. To make a solution containing these six major elements, weigh out the following:

mono-potassium phosphate	5.9 grams
calcium nitrate	20.1 grams
magnesium sulfate	10.7 grams
ammonium sulfate	1.7 grams

Dissolve each of the above salts separately in about a pint of water to avoid precipitation. Then mix the four solutions together and add enough water to make 5 gallons. The trace elements can be added by dissolving together in a pint of water 0.8 grams of each of the following: boric acid, ferrous sulfate, manganese sulfate, and zinc sulfate. Add 10 cc. of this solution to the 5 gallons previously made and you have a fairly balanced "diet" for growing seedlings and plants. Interesting experiments can be planned by varying the quantities of the materials in the nutrient solution.

— Theodore Benjamin


STRICTLY
MAN
STUFF...

On the light side

Brain teasers

Stupid baby sitter?

When Mr. Gum telephoned a friend, a teen-age baby sitter answered and said she would take a message. "How do you spell your name?" she asked.

"G as in goat, U as in umbrella . . ."

"U as in what?"

"As in umbrella, M as in mustard. G-U-M, Gum."

Later, Mr. Gum decided that the girl was not very bright. What made him think so?

The third line

A straight line is called "self-congruent" because any part of it can be fitted exactly to any other part. A circle has the same property. Can you think of a third example of a self-congruent line?

Penny paradox

How many times does the earth rotate during one complete journey around the sun? The answer depends on your point of view. As seen from the sun, the earth makes 365 1/4 turns. But as seen from a fixed star, it rotates 366 1/4 times. So the "sidereal day" (a rotation relative to a star) is a bit shorter than a "solar day."

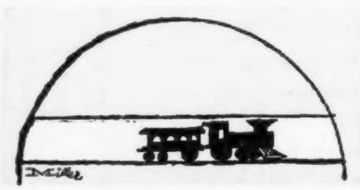
The extra rotation is easily explained by the following simple experiment. Place two pennies flat on a table, edges touching, as shown. Hold the lower coin firmly with your left forefinger while you rotate the other penny around it (the edges should touch at all times). After the penny is back where it started, how many somersaults has Lincoln's head made? The surprising answer is not one but two. To an observer on the central penny, the outside penny would rotate only once, but to you, the "sidereal" observer, an additional rotation has occurred.

Potato puncture

Can a soda straw, held like a small spear, be plunged completely through an unpeeled potato? It seems impossible, but it isn't. Hold the potato and straw exactly as shown. Your forefinger should cover the top opening of the straw. Then, as you move your hand downward, a column of air will be trapped in the straw, keeping it rigid.

Strike the potato quickly, with as much force as you can. Be sure the straw is perpendicular to the surface of the potato when it hits. Otherwise the straw will tend to crumple.

It may take a bit of experimenting to get the knack [*our score: fifteen tries* — Ed.]. But once you master it, you can puncture the potato almost every time. After a successful spearing, you'll find a neat little potato cylinder tucked tightly inside the end of the straw.



Gravity train

Charles Dodgson, the Oxford mathematician who wrote books for children under the name of Lewis Carroll, proposed this curious railroad in *Sylvie and Bruno*, one of his less familiar novels. The tracks are in a long tunnel that makes a perfectly straight line through the earth from one city to another. The center of the tunnel is nearer the earth's center than is either end. So the train coasts downhill for half the distance, gathering enough momentum to carry it up the other half. The only propelling force is the earth's gravity.

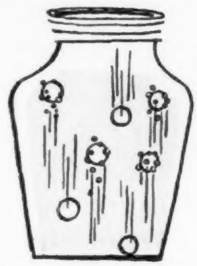
If we ignore friction and air resistance, such a train would actually work. It would make the trip in a little more than 42 minutes. Oddly, this time interval is a constant. It is not affected by the length of the tunnel, even though the tunnel may go straight through the center of the earth.

Dancing mothballs

The next time you give a party, try this conversation-provoking centerpiece for the refreshment table.

Fill a glass jar or pitcher about half full of water, then toss in a handful of camphor mothballs. Add soda water, pouring it slowly. Stop pouring as soon as the mothballs rise to the surface. That's all you have to do.

The balls will stay on the surface for a half-minute (more or less), sink to the bottom, then rise again. The



up-and-down motions will continue for an hour or so.

If you prefer, you can use baking soda and vinegar instead of soda water. Put the mothballs in a jar about two-thirds full of water. Dissolve a teaspoonful of soda in the water. Add vinegar until the action starts.

In both cases, the movements of the balls are caused by bubbles of carbon dioxide. These cling to each ball and float it to the surface. The bubbles then break, allowing to ball to sink again. — George Groth

Answers

STUPID BABY SITTER? Since the girl heard the U correctly, it was unnecessary to know what word it began. (Actually, the girl wasn't stupid at all. Her sense of humor was just too subtle for Mr. Gum.)

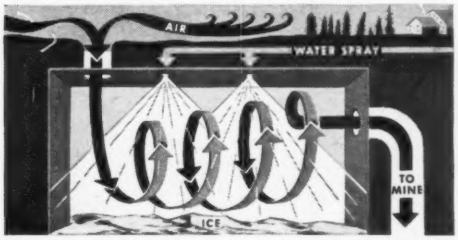
THE THIRD LINE: The helix — a line that spirals forward like a corkscrew.

Freezing water to warm a mine

Inco shows a king-size operation that helps mine more Nickel

The bigger the mine, the more men at work, the more *air* they need. Gales of air. Warmed in winter. Cooled in summer. That's the reason for this mammoth "air conditioner" in an Inco-Canada mine.

In winter it raises the temperature of cold air from outside *by making ice.* In summer it uses the ice to cool air that's too hot! (See diagram below)



In winter, cold air is blown through sprays of warmer water. The water loses its heat, freezes into mountains of solid ice. In the process, the latent heat of freezing is transferred to the air, warms it up for use inside the mine.

At full capacity in a winter season, this system alone can generate as much heat as 350,000 gallons of fuel oil. During this period, 150,000 tons of ice may form. (See photo at left)

Installations like this are expensive in time and money. Such outlays are typical of many made by Inco-Canada. Their cost adds up to millions. Results are—to continue the increased production of Nickel.

Mining for Nickel is a 45-minute color film loaned to high school science groups, college engineering classes and technical societies. Write to Educational Service, Development and Research Division,

The International Nickel Company, Inc.
New York 5, N. Y.

International Nickel

The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada) — producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium and Platinum, Palladium and Other Precious Metals.

A mountain of ice, built up in this inside-a-mine "air conditioner." The rock chambers, or "stopes," where the ice forms, are high as a 23-story apartment, big enough to house 300 families. Things have to be done in a big way to get Nickel in the tremendous amounts used by industry to make metals that perform better, longer.

Continued from p. 4-T

Projects and experiments

1. Ask a student who is an amateur radio operator to build a quartz oscillator. Connect the output to an oscilloscope to observe the constant frequency on the screen. You can usually borrow an oscilloscope from the physics department of your school or of a nearby school, or from a local TV repairman.

2. Have students build models of historical timekeeping devices such as the shadow stick, the water clock, the candle clock, the sundial, and the hourglass.

ARTICLE: Rockets, missiles, and satellites (p. 13)
TOPICS: action and reaction; gravity

Here, students will find a review of the history of rocketry and of rocket theory and application. A logical place to use this material is in the introduction to Newton's laws of action and reaction and of gravity. The teacher can use the article to show the need for learning the basic principles of mechanics involved.

Discussion questions

1. What holds a satellite in orbit?
2. What kinds of fuels are used in rockets?
3. What are the disadvantages of air-breathing engines?
4. Why are several stages required for getting a satellite into orbit?
5. How does size of the orbit affect the speed of the satellite?

Projects and experiments

1. Have students build a model of a multi-stage rocket.

2. Demonstrate a rocket as follows: attach a carbon-dioxide soda cartridge to a model plane. Suspend the plane on small pulleys from a wire stretched across the classroom. Release the carbon dioxide by using the special tool for this purpose, which is sold in hobby shops, or use a sharp-pointed nail hit by a hammer.

How to make it

A microgram scale

In teaching the metric system, physics teachers often have trouble giving students a clear mental image of weights as light as milligrams and micrograms — unless a fine analytical balance is available. But even without such a balance it's possible for students to experience the handling of these weights. A balance that will weigh to millionths of a gram can be made from the following: a block of wood 3" x 1" x 1", two halves of a microscope slide (or other small pieces of smooth glass), two very fine sewing needles, a drinking straw, a one-inch wood screw, and a piece of Styrofoam 1" x 1" x 2". Styrofoam may be obtained in hobby shops and in florist shops. To make the balance, proceed as follows:

With a knife, cut the Styrofoam to the shape shown in Fig. 1. Then insert the needles and secure them in place with a drop of model-airplane cement. Cut out the block of wood to form a letter "U." Next use a nail to make a hole for the drinking straw in the lower center of one face of the Styrofoam. Insert the straw in the hole. On the other side of the Styrofoam, just below the straw, insert the screw at an angle of 30° to 45° from the horizontal. On top of the legs of the U-shaped wood block, cement the pieces of broken microscope slide. Place the Styrofoam balance assembly on the U-block so that the needles rest on the glass.

Now build a glass, cellophane, or plastic house, as shown below. Adjust the screw in the Styrofoam until the device is in balance. Then slip the parts into the house. At one end of the house place a square of glass, as a door. On the outside center of the door cement a paper scale.

Now to calibrate the balance. Get some No. 40 copper wire. Then with a razor blade, cut it into ½-centimeter

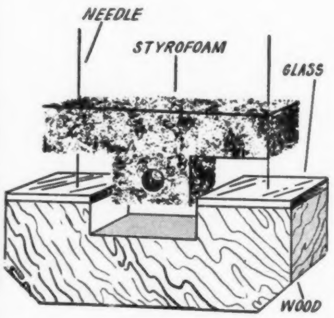


Fig. 1

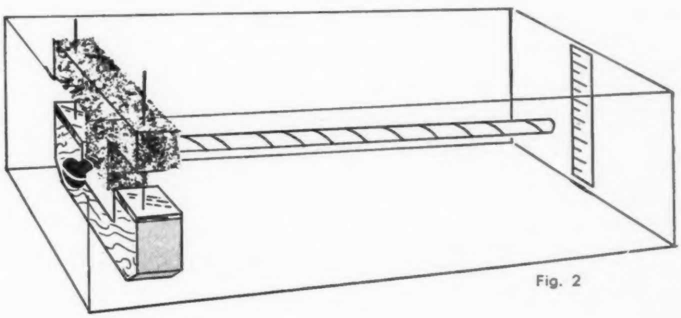
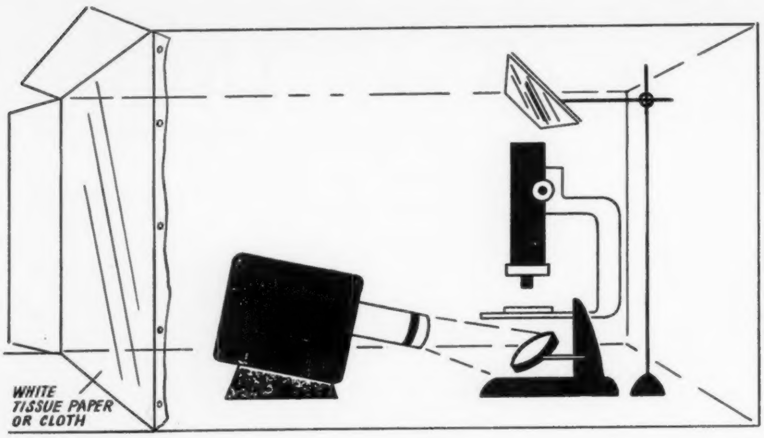


Fig. 2



lengths. Using tweezers, insert these weights one at a time into the end of the drinking straw. When a weight is added to the balance, close the glass door with cellulose tape to prevent air currents from moving the balance. After each piece of wire is inserted, mark the position of the straw on the scale. Each piece of wire will weigh 225 micrograms, or 225 millionths of a gram. The weight of 4½ pieces of wire will be about equal to one milligram.

When the balance is calibrated, ask students to weigh tiny pieces of paper, ½-cm. lengths of human hair (red, blond, and brunette), and ½-cm. lengths of insect wings.

This balance is patterned after the double-beam Zehnder's balance, but is a single-beam type. Its sensitivity will turn out to be 45 micrograms per centimeter.

Some students have used a milk container as the housing for the balance. The top of the container and one side are cut off. The container is placed open-side up. A glass or plastic door is added.

A microprojector

Many teachers whose schools lack a microprojector have the makings of one in their own classrooms. All that is needed is a lantern slide projector and a microscope. A projector with a 500-watt lamp gives the best results. It may be a 3 1/4" x 4" or a 2" x 2" slide projector. If a regular microscope isn't available, a good-quality miniature microscope may be used. Here's how the two instruments can be combined to project enlarged images of microscopic subjects:

Remove the front (objective) lens of the projector. Then remove the eyepiece of the microscope. Switch on the projector. Prop up the back end so that the light beam from the projector fills the microscope's substage mirror. In a darkened room, adjust the mirror until a bright spot of light focuses on the ceiling. Move the projector back and forth until you have the brightest spot. Set the low-power lens of the microscope into position.

Now place a specimen slide on the microscope's stage. Focus the microscope until you see a bright, sharp image on the ceiling. This will be a circle about two feet in diameter. To examine living protozoa, simply place them in a Petri dish on the stage.

If a piece of white cardboard is fastened two feet above the microscope and the microscope refocused, an image several inches in diameter is produced. This can be examined from close at hand. If a pocket mirror is placed above the viewing end of the microscope, at an angle of 45°, the image can be focused forward onto a motion picture screen.

If the classroom or laboratory cannot be darkened during the day, the microprojector can be converted for daylight use in the manner illustrated. Set a large carton on its side. Assemble the microprojector inside the box. Next set a pocket mirror on a stand above the microscope, at an angle of 45° from the vertical, as shown. Cover the opening of the box with a large sheet of white tissue paper or tracing cloth. The image will appear on this screen. The flaps of the carton will act as a shadow box to keep side light from washing out the image. As long as direct sunlight does not fall on the screen, students will be able to see projected microscopic images.

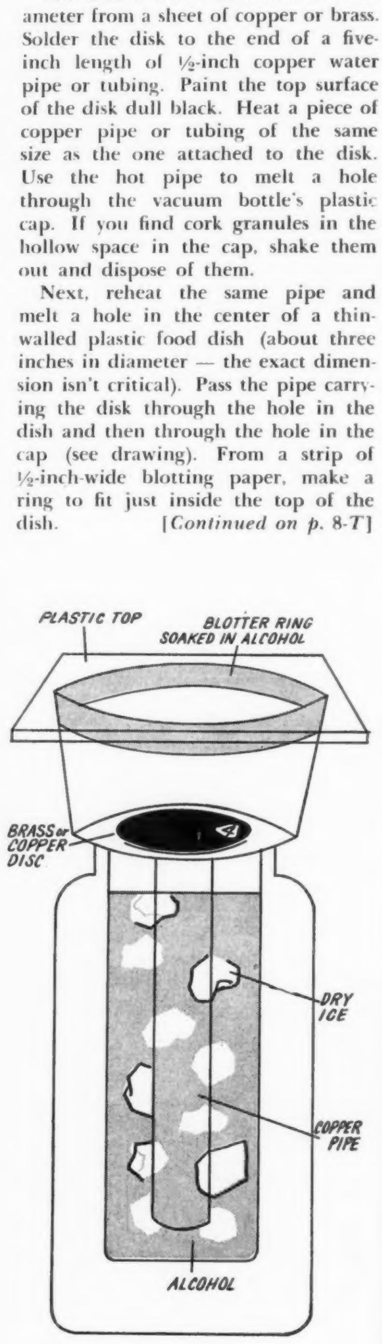
An advantage of this type of microprojector is its ability to collect almost all of the light beam from the condensing lenses of the projector. Little light is lost. All of the light collected is focused by the concave substage mirror onto the specimen on the microscope slide.

A foolproof cloud chamber

Recently, Clifford Little of the Hill School in Pottstown, Pennsylvania, developed a cloud chamber that is almost 100 per cent foolproof. The trick is to use alcohol and dry ice in a small, wide-mouthed vacuum bottle to maintain the required low temperature. To make this chamber follow these instructions:

Cut a disk about two inches in diameter from a sheet of copper or brass. Solder the disk to the end of a five-inch length of ½-inch copper water pipe or tubing. Paint the top surface of the disk dull black. Heat a piece of copper pipe or tubing of the same size as the one attached to the disk. Use the hot pipe to melt a hole through the vacuum bottle's plastic cap. If you find cork granules in the hollow space in the cap, shake them out and dispose of them.

Next, reheat the same pipe and melt a hole in the center of a thin-walled plastic food dish (about three inches in diameter — the exact dimension isn't critical). Pass the pipe carrying the disk through the hole in the dish and then through the hole in the cap (see drawing). From a strip of ½-inch-wide blotting paper, make a ring to fit just inside the top of the dish. [*Continued on p. 8-T*]



MEMO

To: High School Guidance Counselors

From: The United States Army

Subject: The Army's Graduate Specialist Program

During the four years of its existence, the Army's exclusive technical schooling program for qualified high school graduates has prepared many thousands of young men and women for outstanding futures. The Army believes the wholehearted acceptance by students of this great career training opportunity has been due, in large measure, to your counseling support of the program.

Starting this school year, this basic enlistment plan will be known as the Army's Graduate Specialist Program. This memo is to explain to you the way in which the Graduate Specialist Program differs from our previous plan.

The Graduate Specialist Program still enables qualified high school graduates to choose an Army technical training course upon a three-year enlistment. There are 107 courses available for young men, 26 for young women. The qualifications for this program, however, have been changed to provide for even greater precision placement of high school graduates in fields in which they will succeed. Since precision placement lies at the basis of all your counseling responsibilities, we believe you will agree the new Graduate Specialist Program, with its higher qualifications, represents an important advance over the previous plan. Here are the three basic steps for qualification.

1. Enlistment Screening Test. When a high school student applies for the Graduate Specialist Program, he or she will be given an enlistment screening test, to determine the applicant's general qualifications for service in this program.

2. Course Determination. Upon passing the enlistment screening test, the student will discuss his academic background and interests with the Army Recruiter. Based on the information provided, he will be counseled in the selection of his appropriate courses. Then the Recruiter will let the applicant pick a first choice course and two alternates, so that if quotas for his first choice are filled, he may still become a Graduate Specialist in an alternate field. When this selection has been made, the application will be forwarded to a central Army agency for processing. Later, the applicant will be notified that a place in a specific course has been reserved for him.

3. Final Qualification Tests. After high school graduation, the applicant will take two more tests, the Armed Forces Qualification Test and the Army Qualification Battery. He must pass the AFQT and make a qualifying score in those portions of the AQB relating to the specific field of knowledge of his selected course. Only after proving finally qualified does the graduate actually enlist. Then, following basic processing and training, he will go directly to the Graduate Specialist school of his choice.

The Army believes you will agree that through these qualification procedures there is little risk that a high school graduate will find himself in a course poorly suited to his aptitudes.

One further point of information regarding the name of this plan. The Army's technical schooling program in the past has been variously known as "Reserved For You," "Choice of Technical Training" and other general descriptions. In giving the new plan the one specific name, "Graduate Specialist Program" it is believed there will be no confusion as to just which service plan is being discussed. Also, it is felt that the new name more truly indicates the high calibre character of the program, the necessity for participants to be high school graduates, and the Army's long-standing belief that every young man and woman should graduate from high school before considering military service.

If you have any questions regarding the Army's Graduate Specialist Program, and its new qualifications, won't you please write to:

THE ADJUTANT GENERAL
Department of the Army
Washington 25, D. C.
ATTN: AGSN

Wearing gloves, break up dry ice with a hammer into, roughly, ½-inch cubes. Place the dry ice in the vacuum flask. Pour denatured ethyl alcohol slowly over the ice. At first there will be a violent boiling. This will subside when the temperature of the alcohol reaches that of the dry ice. Then gradually add more alcohol until the flask is filled to a point ½-inch from the top.

Now put the plastic cap into place. This sets the copper pipe into the cooling mixture. Soak the blotter ring in alcohol and place it in position, as shown. With tweezers, place a section of a radium watch dial, containing one number, on the black disk. Cover with a 4" x 4" square of Lucite or Plexiglass from 1/16" to 1/4" thick. Rub this with a piece of silk to give it a charge of static electricity. This serves to clear the field of any ions. Use a flashlight to illuminate the chamber from the side.

After a few minutes alpha particles will be seen coming out of the radium number of the watch dial and crossing the disk. The chamber will continue to operate for many hours without any attention. If tracks that do not originate from the radium appear, they are usually cosmic rays. After long observation, students may see a forked track, indicating that an alpha particle (helium nucleus) has collided with a nitrogen nucleus.

If you wish to record the tracks with a movie camera, use a 300- to 500-watt projector as a light source in place of the flashlight. On damp days it may be necessary to recharge the cover by rubbing it with silk at half-hour intervals. On dry days it may stay charged for hours.

Shop talk

Of the many devices used by teachers to show the structure of the atom, one of the most eye-catching hangs in a classroom at West Allis (Wisconsin) Central High School. It's a mobile of an atom (argon 1) fashioned from colored plastic balls, wire, and string. Two feet in diameter, the mobile hangs from the ceiling near the front of the room (but not so low as to obstruct the view of the blackboard). The slight convection currents in the room keep the atom's electrons in constant rotation around the nucleus.

When science department chairman Joseph M. Stefanko first put up the atomic mobile, he was skeptical of its value. But he became convinced of its worth when it generated a good deal of discussion and private investigation by students. He usually hangs it up about two days before his chemistry class begins studying atomic structure.

For those who would like to make the mobile, here are directions:

To represent protons, neutrons, and electrons, use plastic-foam balls of three different colors. These can be bought .in a five-and-ten-cent store. Form two loops in a short piece of wire (Fig. 1). Glue balls representing the neutrons and protons to the wire and to each other to form the nucleus (Fig. 2). To make the orbital rings, thread springy wire through the balls representing electrons. Use string to hold the rings in place. Tie the string to the outer ring at point *A*, loop it around the inner rings at points *B* and *C*, and tie it at *D*. Above the nucleus, the string is looped around each of the three rings, then fastened to the ceiling.


FIG. 1

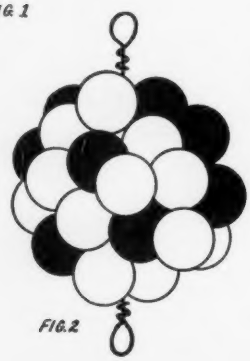


FIG. 2

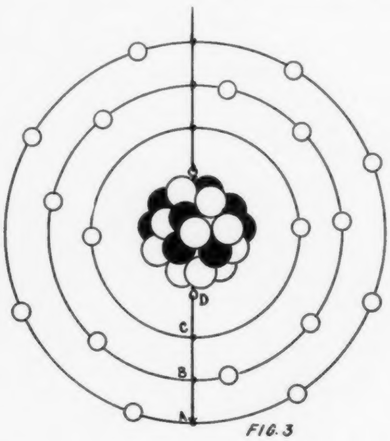


FIG. 3

Twenty-five dollars will be paid for material used in "Shop Talk." The editors regret that they cannot acknowledge or return unused contributions. Address contributions to Science World Shop Talk, 575 Madison Avenue, New York 22, N.Y.

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